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ATHLETICS FOR CITY GIRLS.

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IF any of my readers should chance to belong to a hardy boat crew or to a college ball team, or if in days past they have ever been numbered in such a muscular community, they will doubtless feel that the title of my paper is its own executioner. For so long as baseball and football and the boat race stand for the national expression of athletics, the experiences of girls in any similar department will seem like comparing moonlight unto sunlight, and water unto wine. In speaking of athletics for city girls, however, we shall use the phrase in a liberal sense, including not only out-of-door sports but also the general feats and training of the gymnasium. The spirit for physical recreation has invaded the atmosphere of the girl's life as well as that of the boy, and demands consideration from her standpoint.

Before we consider the influence of athletics, we may well inquire into the physical status of the girl. What is the type of the city girl, and is there any reason to believe that she is in need of any new influence to further her development? In age she is presumably under twenty; at all events, she has not yet reached that period of stable womanly development which physiology places at about the age of twenty-five. She is presumably well housed, well fed, and more or less well clothed, according to the intelligence of her guardians. She spends at least half of her young life in the schoolroom, most of that time at a desk in more or less cramped and unfavorable positions. The average city schoolgirl spends from two to four hours daily in study, according to her ambition, takes a music, drawing, or dancing lesson in

addition twice or thrice weekly, and ends her day with her books or in society, depending upon her environment.

These engagements leave her about one hour's time for out-door life and exercise, and this consists for the most part in a walk on the avenue, or a shopping expedition which often ends in a crowded, ill-ventilated store. Riding and driving are recreations, as a rule, only indulged in by the favored few. Her summer may be a season for physical freedom, but is often one of social dissipation spent in the atmosphere of a fashionable resort.

The product of these various influences is intellectually more or less successful; certainly the American girl, clever, versatile, accomplished, is an interesting type of our civilization. If we analyze her physically we shall find that she possesses the first qualification of a fine physique—viz., height. Bowditch's measurements of ten thousand public-school children in and about Boston show that in stature they surpass their English neighbors, who are popularly supposed to be superior in that respect. The writer has measured between eight and nine hundred New York city girls and women, and has found the average stature with them equal to Bowditch's measurements, sometimes surpassing them, many exhibiting unusual height. In breadth of shoulders, waist, and hips the measurements show them to be fairly well developed, although the American type appears to be less generous in this respect than the English or the German. Happily, the tendency of the day to out-of-door sports has thrown the slim-waisted girl into the shadow of unfashionableness, so that this species of deformity does not necessarily constitute part of the type. In these and certain other respects Nature has evidently intended by her original drawing to give the girls what we may call a fair chance.

But the average city girl of our experience has two or three marked physical deficiencies that are worth considering. The first of these is a shallow chest, the second is a lack of symmetry in the body, and the third is a deficiency in muscular development. The relation of the depth of the chest to the development of the vital organs is a highly important one. The "deep-chested Juno" is given us as a type of noble physical development, and we rightly associate such a conformation with what is known as the *staying* power. A deep chest offers a generous cage for a robust heart and expanded lungs, and is almost invariably found in athletes, who must have endurance, as well as in singers, whose efforts likewise must be long sustained. It has been found that persons most susceptible to the infection of phthisis commonly have a conformation which has been called the *phthisical habitus*—viz., a long, rather narrow, and especially a shallow chest, flattened from before backward. Whether Americans exhibit this

conformation oftener than those of other nations is not precisely proved, but we are inclined to think that such is the fact. Certainly the shallow chest is present in the case of many girls examined by the writer.

The second noticeable feature, the lack of bodily symmetry, is a patent fact to all physicians who have been called upon to make physical examinations of the bodies of children, and the art of the dressmaker is continually required to conceal defects of this nature. They arise partly from habits of faulty postures in school or at home during the plastic period of growth, and largely from the coincident lack of muscular vigor which is due to the absence of proper training. From twenty-five to thirty per cent of all cases examined by the writer exhibit some degree of unsymmetrical development of the body, many of these cases showing a degree of lateral curvature of the spine, more or less marked, according to the influences which have been at work. It is a noteworthy fact that children are not born deformed, and therefore most of these minor asymmetries assume special importance as being acquired mainly through faulty hygienic conditions of environment which obviously call for every counteracting influence at our command.

The third deficiency we noted in the development of our city girl is the lack of muscle. With this we are also concerned—first, because a girl who has small muscular strength is continually living below her capacity for usefulness as well as pleasure; and second, because the external muscles of the body are the natural outlets for excessive nervous energy, as well as the great stimulators of the functions of circulation, digestion, and respiration, while the internal muscles are so widely distributed in the great organs of the body that their vigorous condition is absolutely necessary for its health. We have physiological reasons for believing that internal muscular structures often partake of the same flaccidity and nervelessness as is sometimes exhibited by the external muscles; the softened heart muscle following certain diseases or a relaxed condition of the muscular coats of the stomach is capable of working serious ill, as every practitioner can testify.

That the muscle of girls is weaker than it need be we have ample proof in the statistics of our gymnasiums, which record the physical tests of strength taken at the beginning and the end of a course of physical exercise. These tests are taken with various dynamometers, and with these we find that a short course of two or three hours weekly, extending over six months, will often double the strength of the principal muscles of the body in girls from fifteen to twenty-five years of age.

Such improvement indicates that these girls were previously

much below their own possibilities of development, and suggests what might have been done for them in this respect years before, had similar advantages been offered them earlier in life. The tests taken of "lung capacity" on the spirometer before and after the course, as well as measurements of the chest circumference, tell by their marked improvement the same story.

Apropos of the lack of muscular vigor in city-bred subjects, we may note that oculists believe that the very marked increase in myopia among Americans during the past few years, which is especially noticeable in city life, is partly due to muscular relaxation, which deprives the tissues of the eye of their proper support and permits the degree of bulging of the globe which is an essential condition of this disease.

But granting the fact that her physical development is not perfect, what can we say of her general health? Passing by serious diseases, it is evident that our city girl has a variety of functional complaints which should have no place in the physical history of young people. Headaches, backache, dyspepsias, neuralgias are far more common than they should be. Nervously she is not *stable*, as the increasing number of nervous difficulties, neurasthenias, etc., would indicate. The emotional strain of conventional city life, which is felt more by the society girl than by the schoolgirl, is not an ideal atmosphere in which to cultivate the perfect flower of a stable character, and those who apparently bear it well do so at some expense of strength and nerve.

This hasty glance at the features of our city girl would lead us to believe that she requires not necessarily less attention for her brain, but more for her body than has hitherto fallen to her lot. She shows the lack of influences that will grow muscle and sedate nerve and promote functional health—in a word, some definite physical training. Her functional complaints are such as the experienced physician treats with exercise and pure air, and her narrow chest and unsymmetrical body will find their only rectifiers in these same influences.

Given the limitations of a town environment, where and how shall she gain these things? All intelligent persons agree upon the necessity for exercise, the manner of taking it being perhaps the possible point of controversy. As for the amount required, physiologists have agreed that in general terms a man requires exercise equal to a walk of nine to ten miles daily, and we may therefore estimate that a woman should have not less than an equivalent of five miles to maintain her in good health. Our city girl can not run wild in the fields to obtain this exercise, or live the life of a gypsy. She must be educated mentally as well as physically, and the problem evidently resolves itself into providing some means which will give in our rather limited winter

session the maximum of properly arranged exercise in the minimum of time.

First of all, every out-of-door sport that she can suitably undertake should be open to her, both in the sense of opportunity and also in that of consenting public opinion. The only two sports that are practicable during any considerable part of the city season are tennis and bicycling, for rowing is limited to too short a season to be considered, and riding is by reason of expense not open to the general public. As regards tennis, she is already possessor of the game so far as knowledge and public opinion are concerned, and, although objections have been raised to it on the score of its being too violent exercise, there appears to be nothing essential to the game which a healthy young woman may not engage in, if she is properly dressed. A girl who is delicate or who has any organic disorder should certainly consult her medical adviser before playing any very active game, but these exceptions should not be allowed to rule the game out for the large class of girls who are physically qualified to enjoy and profit by it. The old rule of moderation in all things must obtain in this exercise as elsewhere.

The mention of the bicycle for women opens a field of mild controversy which is only important because some of the objections to its use are taken from the hygienic standpoint as well as from the social. Many objectors contend that the wheel is as undesirable for women as the sewing machine, while the majority of parents seriously object to what they feel to be the unpleasant publicity of the exercise. As a matter of health, which is of the first importance, the writer has made many inquiries among women who use the wheel regarding the effects of the exercise upon them, and has failed to discover a single case of injury or poor health resulting from its use. On the contrary, the testimony to its exhilarating and healthful effect is universal. Several other American physicians, qualified to speak from experience in their practice among women, have warmly commended its use. From the standpoint of a symmetrical exercise, the position is preferable to that on a horse. The movement is unlike that of the sewing machine in several important respects: Instead of being bowed over in a cramped position which restricts the action of lungs, digestive and pelvic organs alike, the woman rider sits erect, with full opportunity for chest expansion, while the difference between the environment of the sewing woman and the riding woman as regards indoor and out-of-door life is most important.

The bicycle is one of the few out-of-door sports open to the average woman by reason of its convenience, comparative inexpensiveness, and pleasure; and if it need not be ruled out from

hygienic reasons, I believe that we owe it to our girls to allow no others to interfere with its introduction. It is already used extensively in some of our largest cities, while in England it is popular with many whose word is fashion's law. It can not be contended that it is essentially unwomanly. It is only at present, in cities like New York, unusual, peculiar, and therefore unfashionable. In the interests of sound health and physical recreation for the city girl the social objection may well be set aside, with the expectation that the introduction of the wheel for women will be followed by the best of results.

But with tennis practicable only in the spring and autumn, and cycling still a matter of the future, athletics for our city girls would seem to be narrowed to slender resources. What means can they employ during the long winter months for keeping muscle, nerve, and brain in good physical order? The well-ordered, properly equipped gymnasium would appear to be the only practicable substitute in the winter months for the invigorating sports possible only to the favored few, or necessarily limited to the summer season. In such a gymnasium some definite system is important. Whether it shall be Swedish or German, class work or individual practice, will be a question to be decided separately for each place. A good teacher can arouse interest with or without apparatus, in classes or individualizing her work, as required. The requirements for the building itself are abundance of fresh air and sunshine, space, and exacting cleanliness. A physician should direct the work of each pupil, endeavoring by special prescription to overcome existing deficiencies, to stimulate the will and energy in the sluggish, and to limit nervous expenditure in those of a nervous temperament.

A young girl entering such an institution will have every safeguard against harm thrown around her. Her age, strength, previous and present health will be inquired into, and heart and lungs tested to ascertain their soundness for exertion. Any lack of symmetry, as shown in the condition of the spine, shoulders, or chest, will be noted. Her inspiratory power and muscular strength will be recorded, and the individual equation will have due weight. She will be placed in a class where the general average of strength is equal to hers, but she will be advised to avoid or increase certain exercises, according to her personal needs, and to report to the director at certain intervals for further advice.

Is there any place where the quantity and quality of a girl's exercise is as carefully supervised as in this ideal gymnasium? In such an institution the system is a progressive one, and in the hands of a good instructor always remains interesting. By easy steps the pupils are led from simple to intricate exercises, reaching the most advanced work in the course of two years' training,

always provided that by preliminary exercises they have gained sufficient strength and skill.

Our young pupil at the close of her hour's exercise takes a sponge or a spray bath or none at all, according to her prescription; always a brisk rub and a complete change of undercloth-ing are advised. The general benefits to her of such training lie in the fact, first, that it exercises the entire body in a systematic, practicable manner, as no other city exercise can do. A horse, the bicycle, or a long walk, all admirable, require fair weather for their enjoyment. The gymnasium, dry, clean, cheerful, invig-orating, offers variety, companionship, and physical recreation equally in storm or shine, and this is no small consideration in arranging a programme for the physical improvement of the city girl during the winter months. The regularity of the exercise is not the least of its benefits. When one has made a financial sac-rifice for the pleasure of keeping a regular engagement, she has an excellent guarantee that the engagement will be met. We are all creatures of habit, and advantage should be taken of the fact in the physical as well as in the intellectual realm, and Nature's rewards are most generous to the child of system.

The particular benefits of gymnastic and athletic work for girls have been demonstrated by exact methods more palpably than is generally known. A system of measurements and tests has been introduced in many gymnasiums, as already noted, whereby the physical proportions of the individual are taken upon entering and also at the expiration of the term of exercise, and the resulting evidence has become not only highly interesting but conclusive as to the influence of such systematic exercise upon health and development. It is not unusual for girls to gain in six months' time several pounds in weight, two inches in chest circumference, and from twenty to fifty cubic inches in inspira-tory power, while the dynamometers may show an increase in muscular strength of from fifty to one hundred per cent over the original tests.

The constitutional benefits are not less marked and are by far the most important. To general inquiries regarding health the common reply is, "I feel so much better than I did in every way." In one, the chronic headache is relieved; the tendency to colds in another has been arrested; in the third, functional pain has dis-appeared. The body is more ready for work and more capable for it in every sense. The stimulus of muscular activity has had a profound influence upon the functioning of the whole economy. What is it, after all, that most of us need for health but better functioning? The majority of these young women have not any disease; they have simply been curtailed in their opportunities for generous lung and limb development, and they are still young

enough to respond to the stimulus of well-directed exercise in this gratifying and substantial manner.

The training of the nervous system, which is the immediate result of a systematic practice of gymnastics, is recognized as one of the greatest benefits of such exercise. It is known to physiologists that every group of muscles is controlled by certain nerve centers in the brain, and it is believed that in cases where the life and habits of the individual do not call out the activity of all the muscles, the brain areas which govern those muscles to that extent fail of development. In certain lower animals, for instance, that have been born blind, it is found that the visual area in the brain has wasted away; there being no occupation for its energy, Nature has permitted it to disappear.

As illustrating the value of physical training in stimulating brain function, we have a series of observations made by Dr. Wey, Medical Director of the Elmira Reformatory, showing how dullards who took the lowest standard in scholarship, and in morals as well, became by simple but regular physical drill first more attentive, then more intelligent as to orders, less awkward (i. e., with better co-ordination of the body), and gradually, as the stimulation of the will and energy proceeded, actually better scholars, rising in some cases from the third to the first grade, and improving not only in physical appearance but in moral character. These results were entirely attributed to the awakening of mental energy through the reflex stimulation of muscular exercise.

To these benefits we may oppose the only objections we have known. The first is on the score of danger. As a matter of fact, there is little or no testimony to put upon this side that does not equally apply to many forms of exercise practiced by women, walking included. The theory that girls should not run or climb is long since exploded. Sick girls should not run or climb until they are well, but every physician knows that there would be fewer sick girls if running and climbing had always been part of a girl's early life.

Girls who have organic disease are not fit subjects for a gymnasium—there being a very few exceptions to this rule. Girls with serious spinal curvature require special exercises in the physician's office. Almost all other girls can only be benefited in a well-ordered gymnasium if they obey the rules and follow the advice offered. Any harm that can come from the so-called feats of the gymnasium arises mainly from the possibility that the pupil will not have prepared herself sufficiently for the exercises by previous preliminary training. Oversight and prescription on the part of the director obviate these difficulties. It should be understood that the special value in many of these exercises lies in their educational influence upon the nervous system. They call for a

quick co-ordination of muscles, for pluck, perseverance, and self-possession, far more than for mere strength, and are legitimate training, therefore, for girls, so far as they are qualified to undertake them.

A more valid objection to the gymnasium is that the exercise must be taken indoors, but this is largely overbalanced by the advantages of system and purpose in the course, and is reduced to its minimum by the fact that a well-ordered gymnasium is cool, clean, and well ventilated. The suggestion often proffered that domestic work offers as good a field for exercise for girls is not, in the writer's opinion, tenable. An atmosphere of dust is not an ideal one for physical training, and the elements of system as well as of physical recreation are lost in this scheme, for few households could arrange their economy so as to combine the schoolgirl's leisure with their own convenience, while the drudgery of the employment would cause it to be abandoned whenever possible.

It is not our intention to claim that the gymnasium is the permanently ideal place for every sort of physical training or athletic sport for girls, but only that it does at present offer the greatest good to the greatest number of our city girls in the direction of their physical development and recreation. An out-of-door inclosure for games and sports in pleasant weather would prove a great addition to its advantages. It does not seem an impossible plan for the private schools of our city to co-operate in establishing such an out-of door playground as this, with an instructor in games and sports, and hours arranged for each school department. Such a ground would prove a practical and useful extension of our too limited park life.

WITH an apparatus sensitive enough to measure changes in temperature amounting to only a millionth of a degree, Prof. S. P. Langley has located exact more than two thousand lines in the infra-red spectrum, in which two thirds of the sun's radiation is contained, and has succeeded in extending the spectrum to six times the length of the photographic spectrum. He has tested his instrument in the region of the sodium lines, and found it could not only divide these, but could detect the nickel line between them. By a special device, depending on the use of a cylindrical mirror, he was able to convert automatically the galvanometer tracings into a linear spectrum. He thought the extended spectrum would be of use in forecasting the weather, because it contained a rain band; moreover, the greater part of the lower spectrum seemed to be due to telluric causes. In the discussion of the author's paper in the British Association, the chairman of the Physical Science Section spoke of it as the most important paper that would be communicated to the section. Prof. Lockyer said that the work had done for the lower spectrum what Kirchhof had done for the visible rays. Lord Kelvin admired the marvelous precision of Prof. Langley's method, and the skillful way in which it was carried out.

RESPONSIBILITY IN CRIME FROM THE MEDICAL STANDPOINT.

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THE reason why a physician should be called upon to discuss such a subject as responsibility in crime must be because some organ or organs of the body are concerned, and he ought to know more about the structure and function of the bodily organs than other people. I believe medicine must furnish all the essential fundamental facts in the study of this subject.

According to the medical view of responsibility in crime, the mental status of the individual has to be investigated. In times past, a wide diversity of views has obtained regarding mind. Popularly expressed, some of the salient features of the view which has obtained for several centuries past have been that mind was a special endowment, bestowed by the Creator upon man, and upon no other animal. In some way not quite clearly understood, a will was also given to man, by which he was allowed a sort of freedom to choose as to whether he should allow the Creator to control his mind, or whether he should yield the management of it to an opposing power or Satan. Various manifestations on the part of the individual were regarded from time to time as evidence that either one power or the other had control, according as his conduct corresponded or not with what was commonly regarded as the best interests of the society in which he lived. The ordinary symptoms of acute mania were regarded as positive evidence that the evil one had possession, and the treatment consisted in placing upon the afflicted person charms, amulets, etc., which were regarded as obnoxious to the evil power, with the hope of making his tenancy uncomfortable, and thus inducing him to withdraw.

This view is the last survivor of those once so prevalent, which sought to explain everything of a mysterious nature by hypothecating an omnipotent personality presiding over it, and it prevailed exclusively during the early growth and development of our present criminal law.

Now, it is the proper province of modern medicine to study the construction and function of all the bodily organs, but for various reasons the brain has been the last of the larger and more important organs to be carefully studied; within the last decade, however, it has been very thoroughly investigated.

The result of that study tends to show—indeed, has demonstrated—that the functional product of the brain is mind, in precisely the same sense that bile is the functional product of the

liver; that one process illustrates just as forcibly the influence of a mysterious force or power as the other.

The product of the liver, the bile, will vary according to the size, quality, and condition of the organ and the forces acting upon it; and the same is true regarding the functional product of the brain, the mind. Without liver there is no bile, and without brain there is no mind. At least the physician only investigates mind, which is a functional product of brain. The analogy, however, between brain and liver does not hold throughout, because after birth, and from that period to maturity, and indeed while

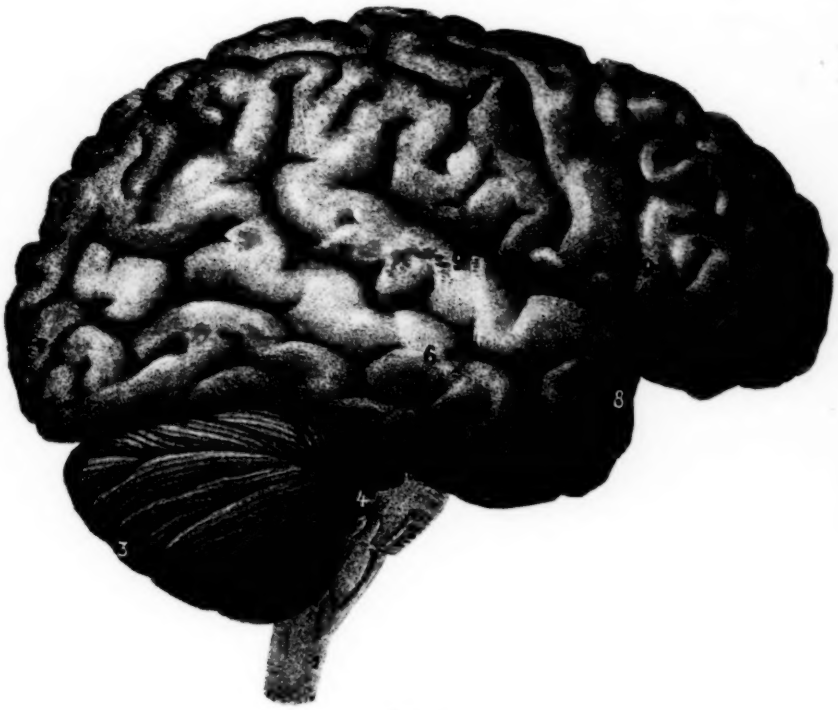

FIG. 1.

life lasts, the brain is ordinarily exposed to impressions made by an ever-changing environment, while the environment of the liver remains practically uniform.

It may be conducive to a clear understanding of the medical view of mind, and therefore of responsibility, to examine objectively the organ itself, and briefly the manner in which its functions are studied by the physician. I need hardly remind you that the brain is a double organ, and therefore only one half of it need be shown.

Figs. 1 and 2 are exact representations of the outer and mesial surfaces of the human brain.

Like many other organs of the body, its functional activity depends upon the presence of cells, the bodies of which are exclusively found upon its surface, extending to a depth varying from one eighth to one fourth of an inch, and constituting the so-called

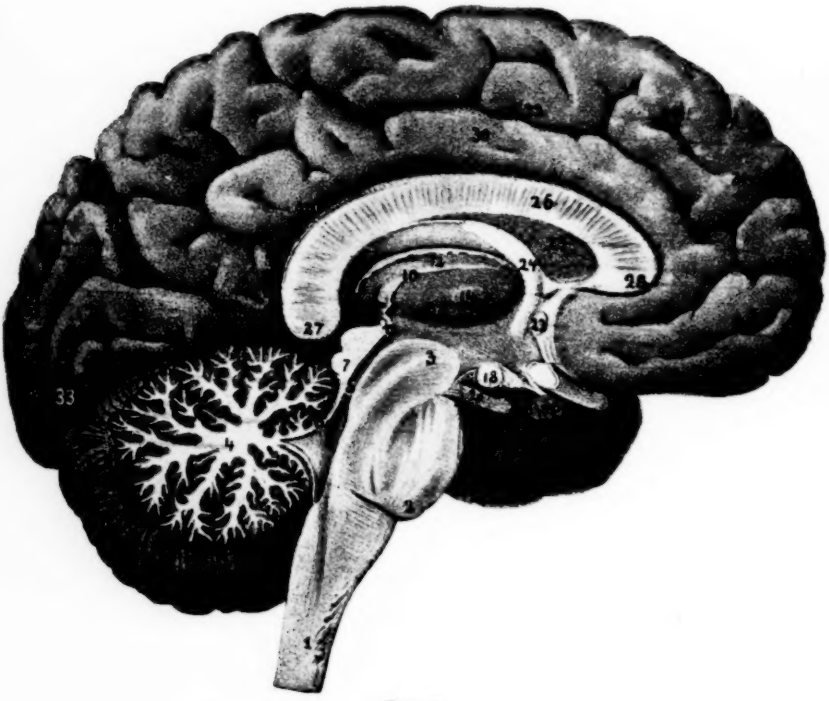

FIG. 2.

gray matter of the brain. The convoluted arrangement of the surface, as can readily be understood, more than doubles its area. Beneath the gray matter, or cortex, is found the white matter, which consists of fine fibrous processes extending from the bodies of the cells in the gray matter, and connecting those in one part of the cortex with those in another part.

Fig. 3 shows the course of the fibrous processes of the cells of the cortex of the brain as they pass from one convolution to another, connecting together the various cell bodies.

Fig. 4 shows a cell and its processes which properly constitute the essential anatomical and physiological unit of the brain, and indeed, speaking more generally, any nervous system.

Fig. 5 shows how these cells in the cortex, or gray matter of the brain, besides sending out processes as already described, also send processes to cells distributed the whole length of the spinal cord. These cells in the spinal cord in their turn send similar processes out along the nerves, to terminate in the skin, muscles,

the eye, the ear, etc., all of which in neurology are called end organs; and thus a passage is afforded for impressions made upon these end organs by the environment to reach the cells in the cortex, and for impulses to return from the cells in the cortex to the end organs, perhaps producing, restraining, or regulating movements in them.

Now a few words as to methods of investigation. Figs. 6 and 7 are charts showing the areas in the brain presiding over certain functions as thereon indicated. Take, for instance, the leg center. A case is found with sudden, complete, and permanent paralysis of the leg; after a few months the person dies, and upon examination of the brain and spinal cord it is observed that a hæmorrhage has destroyed the cells in the part of the brain here indicated. Now, as might be expected when the body of a cell is destroyed, its processes perish; hence, when consecutive sections are made across a strand composed of these cell processes, the bodies of which have been destroyed, and the sections are placed in a solution of coloring matter, it is found that the fibers which have perished take a different color from those which have not, and thus their position may be determined. In this case, by this method, a large strand of fibers which have perished may be

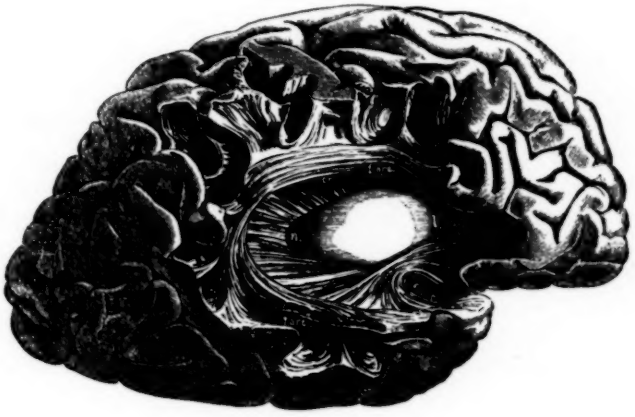

FIG. 3.

traced from the brain downward very near to the lower extremity of the spinal cord. This is known as the clinical method of study. These centers have also been removed in the course of surgical procedures, with the invariable result of producing a corresponding paralysis; and similarly they have been stimulated by electrical currents directly applied to them, and movements produced in the corresponding parts. This latter method is known as the excitation method; to this, as practiced upon the brains of monkeys some thirty years ago, we are indebted for the commence-

ment of the study of cortical localization, and indeed for the removal of psychology from the realm of speculation to that of scientific demonstration.

The method of removing certain cortical areas of the brain and then noting the effect is termed the extirpation method; it was by this method, practiced upon monkeys, that Prof. Schäfer, of London, and myself established the position of the center for vision in that animal. The monkey's brain is so similar to the human brain that with some modification results may be transferred from one to the other.

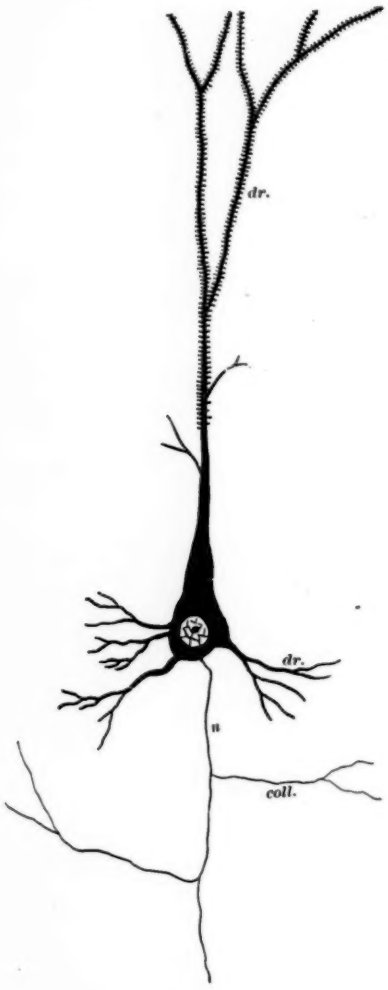

FIG. 4.

Fig. 8 shows the part of the monkey's brain which, when removed, produces blindness in the corresponding half of each eye, and Fig. 9 shows the parts which, when removed, produce complete and permanent blindness in both eyes. Now, while the positions of the areas for the other special senses have not been so satisfactorily demonstrated, the existence of such centers can not be doubted.

With these data, and the aid of Fig. 10, a fundamental step in the process of mental development may be investigated.

By way of the route as indicated in the figure, an impression made upon a specially constructed end organ, the eye, is transmitted along the cell process constituting the optic nerve, and so onward till it reaches a cell, or probably cells, in the occipital lobe; thence by means of the communicating fibers constituting the white matter, and previously described, the arm center is excited and a motor impulse passes out to the muscles moving the arm, and the hand is put into the flame; immediately a second impression is conveyed inward to the pain center and thence to the arm center, from which a second impulse emanates, resulting in a withdrawal of the hand. Finally, after one or more experi-

ences of this kind, the impression produced by the pain being so much stronger than that produced by seeing the candle flame, the attempt to seize it is inhibited, and it finally comes about by means of these association fibers that the sight of flame immediately excites this inhibitory center. The cells and processes concerned transmit the impressions more readily by each repetition until the result becomes uniform; the child has learned something, and finally the desire diminishes. By the process of induc-

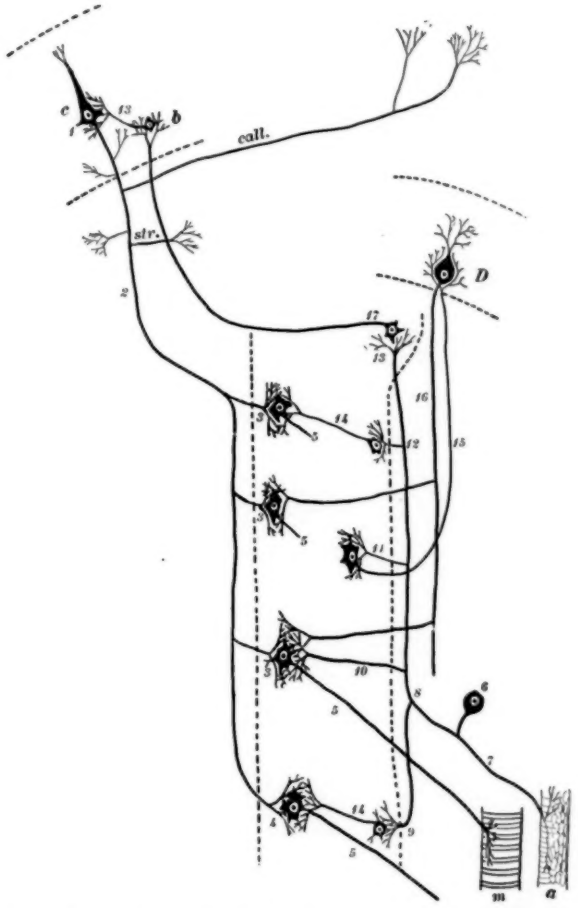

FIG. 5.—*a*, skin on the surface of the body; *17*, a sensory cell in the medulla oblongata; *b*, sensory cell in the cortex of the brain; *c*, motor cell in the cortex of the brain; *D*, cell in the cerebellum where muscular movements are co-ordinated; *3*, motor cell in the spinal cord; *m*, muscle. The course of a stimulus at "*a*" can readily be followed to the cortex of the brain and back again to the muscle, resulting in a muscular movement.

tion from simple examples like this, those which are more complex may be explained. Here Nature inflicted the penalty in the form of bodily pain, which resulted in the establishment of a permanent inhibitory center. In a similar way society attempts, by

the various influences and modes of training to which it subjects children, to establish in them permanent and sufficient inhibitory centers which shall enable them to conform to the various artificial restraints imposed by an advanced civilization. And in the latter, as in the former case, when the inhibitory impression has become well established the desire diminishes. Each successful resistance of temptation renders resistance more easy and certain.

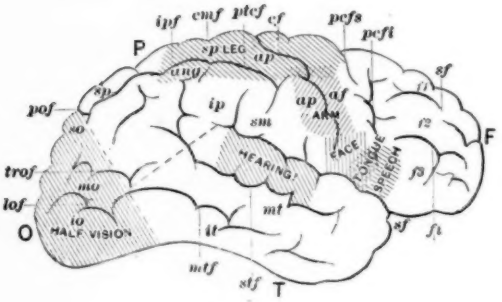

Fig. 6.

In the former as well as in the latter case the readiness with which these inhibitory impressions are received and retained depends upon the quality of the cerebral tissues, the cells.

In the lower forms of idiocy, individuals are often seen who never can be taught to refrain from putting their hands into a candle flame, and the well-recognized criminal class is largely composed of individuals whose cerebral tissues are of so inferior an order that permanent and sufficient inhibitory centers can not under any circumstances be so established as to enable them by themselves to conform to the restraints which civilization imposes.

Sound and successful training attempts to establish these centers of inhibition, and not to prevent their formation by keeping the individual in ignorance of the conditions which demand their exercise. When young people with this false training are thrown upon their own resources, great suffering is almost sure to follow.

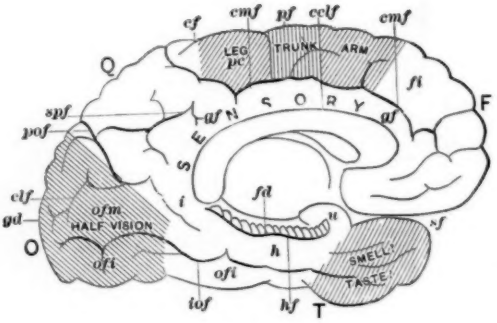

Fig. 7.

While doubtless in this country a large proportion of the individuals composing the criminal class are such by reason of defective brain tissues, it is well-nigh certain that a considerable number might never have entered it if from the start they could have had proper training.

A thorough musician may get better music from a defective instrument, with whose defects he is familiar, than a poor musician can get out of a perfect instrument.

Considered from a medical standpoint, habit may be regarded as a tendency which certain correlated brain cells have to act together from frequent repetition having rendered it easy for an impulse to pass from one to the other, with the production of a more or less uniform result. Thus we are indeed literally creatures of habit.

By the time an individual has reached maturity it is observed that he responds to the influences of his environment with more or less uniformity, and in a way peculiar to himself. The nature of this response constitutes his character. If he has strong impulses, which he uniformly inhibits in a manner favorable to the best interests of the society in which he lives, he becomes known as a man of strong character, and finally of established character, and is trusted accordingly. On the other hand, there are individ-

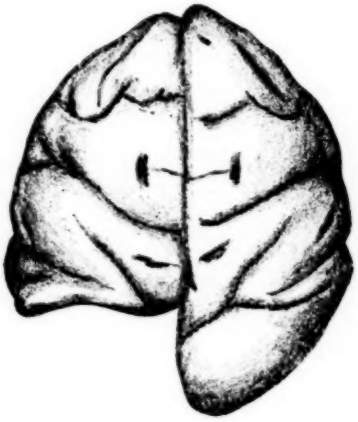

FIG. 8.

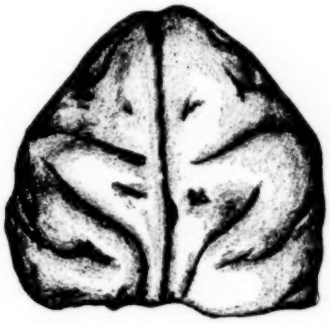

FIG. 9.

uals in whom the response to their environment is so variable that they never succeed in establishing a character, and are never trusted.

At one extreme are found individuals with cerebral tissues of so high a quality that they would establish a high character under the most unfavorable circumstances; and at the other extreme, individuals who would never establish a character under the most favorable conditions; but the great mass of individuals lies between these extremes, and with them the influences of the environment determine their status.

The social and legal penalties visited upon transgressors undoubtedly form a strong and constant stimulus to the inhibitory centers, and the more so in proportion as the individual feels sure that he can not escape from them. A strict and speedy administration of the penal laws should go hand in hand with an intelligent system of training.

It will readily be conceded that no two individuals have exactly the same degree of responsibility, but all must be held to equal responsibility under the law, until it shall be demonstrated in certain cases that a given person is by reason of defective cerebral tissues unable to support the social relation, in which case society should permanently restrain him. This decision should be reached by experts, who would carefully compare the environment to which the individual had been exposed with his mental state, or the functional product of his brain. This, I believe, has actually been done in some States by the enactment of the habitual criminal law, which provides for the perpetual restraint of these cases, without regard to the nature of the last offense.

Without at all suspecting the anatomical and physiological conditions upon which it depends, many intelligent observers, who have been intimately associated with the criminal classes in prisons, reformatories, etc., agree as to the fact that a large proportion are unable to resist the commission of crime, even under the most favorable circumstances, and a still larger proportion under the unfavorable circumstances in which their defective organization tends to force them.

A commission of experts appointed by the State to thoroughly examine the inmates of prisons, to determine their mental status, might do much, by effecting the permanent restraint of certain cases, to diminish crime and the cost and suffering it entails, with a fuller measure of justice toward all parties concerned.

A few words in regard to heredity, by way of digression. It is not disputed that the form which the aggregation of cells takes entering into the structure of a man's nose may be distinctly hereditary, and it is no less reasonable to suppose that variations in the convolutions of the brain are equally hereditary; and that, influenced by the same or a similar environment, the functional product observed in the child will be similar to what obtained in the parent—that is, practically, crime is often hereditary, and to the same extent so may be any other mental tendency.

Finally, a few words in reference to insanity and criminal responsibility. Practically the best definition of insanity is that of Dr. Maudsley, which is substantially this: Insanity is a disease of the brain, producing such a change in the mode of feeling, thinking, and acting as to render the individual unable to support the ordinary relations of life. The question of responsibility is rarely raised in well-developed cases, where the disease of the brain renders the centers inactive and the person sits and mopes in silent misery, or in the cases where the disease of the cerebral structures is so severe as to constantly stir them to irregular and unwonted activity, prompting the individual to laugh, weep, sing,

shout, fight, and pray, perhaps all at the same time as nearly as possible, quite independent of the environment.

The cases of insanity in reference to which the question of responsibility arises are those whose cerebral substance is only mildly affected by disease, so that in many ways the individual still re-

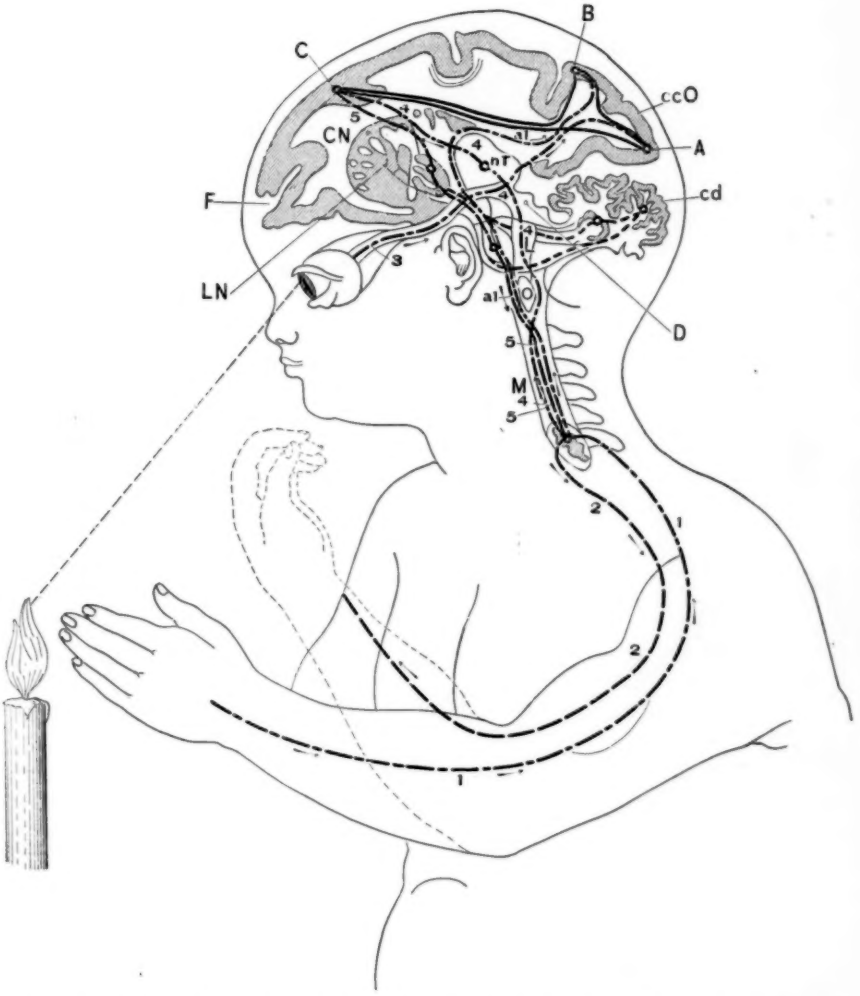

FIG. 10.—The course of the several impulses is indicated by the arrows. An explanation of the figure is facilitated by reference to Fig. 5.

acts to his environment as formerly, especially in so far as his routine duties are concerned; but in other things, where the cells concerned have been less strongly, steadily, and permanently impressed, the disease of the cerebral tissue is sufficient to effect some degree of change in the nature of his response to his environment from what had been usual to him, and it is by studying the

quantity and quality of this change that the alienist determines the existence of insanity. Any specific act by itself does not necessarily afford evidence of insanity, for there is nothing an insane person can do that a sane person may not do.

The experienced alienist by thorough investigation determines as far as possible what has been the previous environment of a person alleged to be insane, and how he habitually reacted to it, and then makes a comparison between that and the manifestations which have been regarded as constituting evidence of insanity. When it is proved to the satisfaction of society that a given act was clearly the result of disease of the brain producing insanity, the individual is usually excused; but until the public becomes more generally informed regarding the bodily basis of mental manifestation, and comes to understand more clearly how and where to look for evidence of insanity, many will be held to be responsible who, according to the intention of the criminal laws, are not so; and some will be excused who are fairly responsible.

It is for physicians to determine the part played by bodily defect or disease in the commission of crime. Society in general must, with this information, determine the degree of responsibility and decide upon the punishment.

THE NEED OF EDUCATED MEN.*

By DAVID STARR JORDAN,
PRESIDENT OF LELAND STANFORD JUNIOR UNIVERSITY.

IF the experiment of government by the people is to be successful, it is its educated men and women who must make it so. The future of the republic must lie in the hands of the men and women of culture and intelligence, of self-control and of self-resource, capable of taking care of themselves and of helping others. If it falls not into such hands, the republic will have no future. Wisdom and strength must go to the making of a nation. There is no virtue in democracy as such, nothing in Americanism as such, that will save us, if we are a nation of weaklings and fools, with an aristocracy of knaves as our masters. There are some who think that this is the condition of America to-day. There are some who think that this republic, which has weathered so nobly the storms of war and of peace, will go down on the shoals of hard times; that we as a nation can not live through the headache induced by the financial sprees of ourselves and others. We are told that our civilization and our government are fit only for

* An Address to the Graduating Class in Leland Stanford Junior University.

the days of cotton and corn prosperity. We are told that our whole industrial system, and the civilization of which it forms a part, must be torn up by the roots and cast away. We are told that the days of self-control and self-sufficiency are over, and that the people of this nation are really typified by the lawless bands rushing blindly hither and thither, clamoring for laws by which those men may be made rich whom all previous laws of God and man have ordained to be poor.

In these times it is well for us to remember that we come of hardy stock. The Anglo-Saxon race, with its strength and virtues, was born of hard times. It is not easily kept down; the victims of oppression must be of some other stock. We, who live in America and who constitute the heart of this republic, are the sons and daughters of "him that overcometh." Ours is a lineage untainted by luxury, uncoddled by charity, uncorroded by vice, uncrushed by oppression. If it were not so we could not be here to-day.

When this nation was born, the days of the government of royalty and aristocracy were fast drawing to a close. Hereditary idleness had steadily done its work, and the scepter was already falling from nerveless hands. God said: "I am tired of kings; I suffer them no more." And when the kings had slipped from their tottering thrones, as there was no one else to rule, the scepter fell into the hands of the common man. It fell into our hands, ours of this passing generation, and from us it will pass on into yours. We are the common man, and you are his heir apparent. You are here to make ready for your coronation, to learn those maxims of government, those laws of human nature, without which all administrations must fail; ignorance of which is always punishable by death. If you are to hold this scepter, you must be wiser and stronger than the kings, else you too shall lose the scepter as they have lost it, and your dynasty shall pass away.

For more than a century now the common man has ruled America. How has he used his power? What does history tell us of that the common man has done? It is too soon to answer these questions. A hundred years is a time too short for the test of such gigantic experiments. Here in America we have made history already, some of it glorious, some of it ignoble; much of it made of the old stories told over again. We have learned some things that we did not expect to learn. We find that the social problems of Europe can not be kept away from us by the quarantine of democracy. We find that the dead which the dead past can not bury are thrown up on our shores. We find that weakness, misery, and crime are still with us, and that wherever weakness is there is tyranny also. The essence of tyranny we have found lies not in the strength of the strong, but in the weakness

of the weak. We find that in the free air of America there are still millions who are not free—millions who can never be free under any government or under any laws, so long as they remain what they are. The remedy for oppression, then, is to bring in better men, men who can not be oppressed. This is the remedy our fathers sought; we shall find no other. The problem of life is not to make life easier, but to make men stronger, so that no problem shall be beyond their solution. It will be a sad day for the republic when life is easy for ignorance, indolence, and apathy. It is growing easier than it was; it is too easy already. There is no growth without its struggle. Nature asks of man that he use his manhood. If a man puts no part of his brain and soul into his daily work, if he feels no pride in the part he is taking in life, the sooner he leaves the world the better. His work is the work of a slave, and his life the waste of so much good oxygen. The misery he endures is Nature's testimony to his worthlessness. We can not save him from Nature's penalties. Our duty toward him may be to temper justice with mercy. This is not the matter of importance. Our duty toward his children is to see that they do not follow his path. The grown-up men and women of to-day are in a sense past saving. The best work of the republic is to save the children. The one great duty of a free nation is education—education wise, thorough, universal; the education, not of cramming, but of training; the education which no republic has ever given, and without which all republics must be in the whole or in part failures. If this generation should leave as its legacy to the next the real education, training in individual power and skill, breadth of outlook on the world and on life, the problems of the next century would take care of themselves. There can be no collective industrial problem where each man is capable of solving his own individual problem for himself.

In this direction lies, I believe, the answer to all industrial and social problems. Reforms in education are the greatest of all reforms. The ideal education must meet two demands: It must be personal, fitting a man or woman for success in life; it must be broad, giving a man or woman such an outlook on the world as that this success may be worthy. It should give to each man or woman that reserve strength without which no life can be successful because no life can be free. With this reserve the man can face difficulties, because the victor in any struggle is he who has the most staying power. With this reserve he is on the side of law and order, because only he who has nothing to lose can favor disorder or misrule. He should have a reserve of property. Thrift is a virtue. No people can long be free who are not thrifty. It is true that thrift sometimes passes beyond virtue, degenerating into the vice of greed. Because there are

men who are greedy—drunk with the intoxication of wealth and power—we sometimes are told that wealth and power are criminal. There are some that hold that thrift is folly and personal ownership a crime. In the new Utopia all is to be for all, and no one can claim a monopoly, not even of himself. There may be worlds in which this shall be true. It is not true in the world into which you have been born. Nor can it be. In the world we know the free man should have a reserve of power, and this power is represented by money. If thrift ever ceases to be a virtue, it will be at a time long in the future. Before that time comes, our Anglo-Saxon race will have passed away and our civilization will be forgotten.

A man should have a reserve of skill. If he can do well something which needs doing, his place in the world will always be ready for him. He must have intelligence. If he knows enough to be good company for himself and others, he is a long way on the road toward happiness and usefulness. To meet this need our schools have been steadily broadening. The business of education is no longer to train gentlemen and clergymen as it was in England, to fit men for the professions called learned as it has been in America. It is to give wisdom and fitness to the common man. The great reforms in education have all lain in the removal of barriers. They have opened new lines of growth to the common man. This form of university extension is just beginning. The next century will see its continuance. It will see a change in educational ideals greater even than those of the revival of learning. Higher education will cease to be the badge of a caste, and no line of usefulness in life will be beyond its helping influence.

The man must have a reserve of character and purpose.

> "To the good man no harm can come, be he alive or dead."

He must have a reserve of reputation. Let others think well of us, it will help us to think well of ourselves. No man is free who has not his own good opinion. A man will wear a clean conscience as he would a clean shirt, if he knows his neighbors expect it of him. He must have a reserve of love, and this is won by the service of others. "He that brings sunshine into the lives of others can not keep it from himself." He must form the ties of family and friendship, that, having something at stake in the goodness of the world, he will do something toward making the world really good.

When every American citizen has reserves like these, he has no need to beg for special favors. All he asks of legislation is that it keep out of his way. He demands no form of special guardianship or protection. He can pay as he goes. The man

who can not has no right to go. Of all forms of greed, the greed for free lunches, the desire to get something for nothing, is the most demoralizing, and in the long run most dangerous. The flag of freedom has never floated over a nation of deadheads.

Then, again, education must take the form of real patriotism —of public interest and of civic virtue. If a republic be not wisely managed, it will fail as any other corporation would; it will only succeed as it deserves success.

The problems of government are questions of right and wrong, they can be settled only in one way. They must be settled right. Whatever is settled wrong comes up for settlement again, and this when we least expect it. It comes up under harder conditions, and compound interest is charged on every wrong decision. The slavery question, you remember, was settled over and over again by each generation of compromisers. When they led John Brown to the scaffold his last words were: "You had better—all you people at the South—prepare yourselves for a settlement of this question, that must come up for settlement again sooner than you are prepared for it. You may dispose of me now very easily," he said; "I am nearly disposed of now; but this question is still to be settled—this negro question, I mean; the end of that is not yet."

This, John Brown said, and they settled the problem for the time by hanging him. But the question rose again. It was never settled until at last it was "blown hellward from the cannon's mouth." Then it was found that for every drop of negro blood drawn by the lash, a thousand drops of Saxon blood had been drawn by the sword.

Thus it is with every national question, large or small. Thus it will be with the tariff, with finance, with the civil service. Each question must be settled right, and we must pay for its settlement. It is said that fifteen per cent of the laws on the statute books of the States of the Union stand there in defiance of acknowledged laws of social and economic science. Every such statute is blood poison in the body politic. Around every such law will gather a festering sore. Every attempt to heal this sore will be resisted by the full force of the timeservers. Such statutes are steadily increasing in number, concessions by short-sighted legislatures to the arrogant monopolist, the ignorant demagogue, or the reckless agitator. This must stop. "They enslave their children's children who make compromise with sin," or with ignorance, or with recklessness. "The gods," said Marcus Aurelius, "are at the head of the administration, and will have nothing but the best."

"My will fulfilled shall be,
In daylight or in dark;
My thunderbolt has eyes to see
Its way home to the mark!"—*Emerson.*

It was the dream of the founders of this republic that each year the people should choose from their number "their wisest men to make the public laws." This was actually done in the early days, for our first leaders were natural leaders. The men who founded America were her educated men. None other could have done it. But this condition could not always last. As the country grew, ignorance came and greed developed; ignorance and greed must be represented, else ours would not be a representative government. So to our congresses our people sent, not the wisest, but the men who thought as the people did. We have come to choose, in our lawmakers, not rulers but representatives; we ask not wisdom, but watchfulness for our personal interests. So we send those whose interests are ours, those who act as our attorneys. And just as the people do this, so do the great corporations, who form a large part of the people and control a vastly larger part. And as the corporations command the best service, they often send as their attorneys abler men than the people can secure. And so it has come about that demagogues and special agents make up the body of lawmakers in this country, and this in both parties alike. They represent, not our wisdom, but our business. They are the reflex of the people they represent; no better, and certainly no worse. Those whose interest lies in the direction of good government alone, often know not which way to turn, and at last fall back on the time-honored anathema—

"A plague on both your houses!"

In this degree republican government has failed. For this failure there is again but one remedy—education. If the people are to rule us, the people must be wise. We must have in every community men trained in social and political science. We must have men with the courage of their convictions, and only the educated man has any real convictions. We must have men who know there is a right to every question as well as many wrongs. We must have men who know what this right is, or, if not knowing, who know how the right may be found. Very few men ever do that which they know and really believe to be wrong. Most wrongdoing comes from a belief that there is no right, or that right and wrong are only relative.

If representative government is ever to bring forward wisdom and patriotism, it will be because wisdom and patriotism exist and demand representation. In this direction lies one of the most important duties of the American university. Every question of

public policy is a question of right and wrong. To such questions all matters of party ascendency, all matters of individual advancement must yield precedence. There is no virtue in the acts of ignorant majorities. The danger of ignorance is only intensified when rolled up in majorities. Truth is strong and error is weak, and the majorities of error melt away under the influence of a few men whose right acting is based on right thinking.

Right thinking has been your privilege: right acting is now your duty; and at no time in the history of the world has duty been more imperative than now.

THE UNIVERSITY AS A SCIENTIFIC WORKSHOP.

By Prof. Dr. FRIEDRICH PAULSEN.

THE peculiar character of the German university springs from its combining the two purposes of instruction and research. It is at once a high school and an academy, meaning by academy an institution for scientific investigation. The relation in which these two functions stand to one another corresponds with the form of the university in the different epochs of its development. The tendency now evidently prevails to give research the preference over instruction. In the estimates of the universities themselves, scientific work has the higher rating. The scientific purposes are most conspicuous in the public view; and the credit in which German universities are held abroad depends first upon their scientific achievements. The estimate is in agreement with the facts, and no wrong will be done to the German professors if we say that many among them work less in instruction than in scientific labor, that they are more academicians than teachers.

It was not always so; it has been so only for a short time. Instruction had the foremost place till in the eighteenth century, and the change that has taken place did not fairly begin till within the nineteenth century. I shall endeavor to trace this development and its causes in a short historical review.

The universities originated in the middle ages as schools. Especially were the universities in Germany, in their beginning, what their official name—*studium generale*—implies, places for general study. The professors were likewise at first called schoolmasters (*magistri regentes, sc., scholas*), and the students scholars (*scholares*). The artistical, now the philosophical faculty, which regularly comprised by far the largest proportion of the students, had wholly the character of a school. Its object was to give

young men from fifteen to twenty years of age a general scientific training. It fulfilled this purpose by explaining, in what were called lectures, text-books containing the recognized material of knowledge, and practicing the students in recitations and exercises. This method still continues in English and American colleges.

No essential change from this method took place in the sixteenth century. The purpose of the philosophical faculty, as Melanchthon understood it, was quite the same, except that classical instruction was added to that in science and philosophy. Completion with a literary and philosophical course of the general scientific training, which began with the grammatical and rhetorical course in the lower schools, was the aim of the teaching which Melanchthon gave at Wittenberg for two and forty years. It was school teaching in scholastic form, so far as certain conditions permitted. So it was Melanchthon's custom to question his pupils in the lessons at the beginning of the hour. The declamations and disputations which he held were likewise pure school exercises. He boasted once in his old age of himself and his friend Camerarius, that they had spent their whole lives in the lowliness of the school, in the *vita scholastica*, in order to serve youth and fair knowledge. A change in the general constitution of the university began with a constant increase in the members of the "higher faculties"—the theological and juridical—for the completion of the university course was more and more held up as a qualification for priestly and secular office. The form, however, of the instruction was still not essentially changed from that of the philosophical faculty. It consisted in the transmission of a teaching of a still fixed substance, only that the hearers were of a greater average age. Connected with this was the dying out of the middle-age form of life; and from the scholar has been developed since the seventeenth century the student.

These conditions lasted without change into the eighteenth century. An instructive study of Kant's career as a teacher has recently appeared.* It resembled Melanchthon's in all essentials, and, like him, Kant also lectured as before him Christian Wolff lectured in Halle, upon all the philosophical sciences—on mathematics and physics, logic and metaphysics, ethics and natural law, besides anthropology and physical geography, and once on mineralogy. Like Melanchthon, Kant also had as hearers young persons, not who studied a little mathematics or physics as their special branch, but who sought chiefly at the university the completion of their general training, in order afterward to apply

* Arnoldt, Königsberg. Altpreussische Monatsschrift, vol. xxx, pp. 7, 8.

themselves to the special study of theology and jurisprudence. Like Melanchthon, Kant also taught single branches from text-books, as was the strict custom, and held recitations and disputations in addition to his lectures. It was still a schoolmaster's teaching. Only the grammatical and rhetorical branches, with the lessons in the Greek and Roman authors, which formed the principal subjects of Melanchthon's lectures, had fallen away. They were no longer among the most important departments in the universities of the eighteenth century, partly because they had become superfluous through the greater amplitude of the preparatory course in the schools, and partly because classical instruction had declined in importance and esteem.

The difference between this and the present German university instruction is apparent on a comparison of the two. The present teaching has entirely abandoned the schoolmasterly character. It aims no more at a general training, but is special, scientific. Mathematics and science are no longer taught by philosophers to hearers of all these faculties, but by specialists to specialists. The ancient writers are not read—as three hundred years ago by Melanchthon and one hundred years ago by Heyne in Göttingen and Ernesti in Leipsic—to the general hearers, for the sake of general training and cultivation, but to philological students for the purpose of inducting them into the technics of the scientific treatment of the text. The name of Fr. A. Wolf, who is given the credit of having raised ancient knowledge to an independent study, marks this revolution. The closest reminders of the old conditions are the lessons called philosophical and a few historical lectures, including the history of literature and art, at which hearers are gathered from the different faculties, and the completion and deepening of the general training is more prominently sought than induction into special studies. The tendency to a transformation is, however, visible here too plainly in History, in which the lectures and still more the accompanying exercises have already the character of professional, special instruction. Signs of the change are beginning to be visible, too, in the philosophical teaching. Psychology, especially, is tending to isolate itself as a special field of scientific investigation. It is further worthy of remark that the faculties have reversed their relation to this branch within the nineteenth century. While formerly the teaching in the philosophical faculty was mostly elementary and general, it is now divided into many branches, and is predominantly special and professional. While in the other faculties the first thing regarded is the preparation of practitioners for their calling as doctors, clergymen, and lawyers—a point that can never wholly be lost sight of—the teaching in the philosophical faculty is various, as if the training of specialists or technicalists

in scientific investigation were the single object. There is nothing to indicate that the students of these faculties expect to be called to practical teaching. The difference is plainest in the seminaries and in the exercises. In the higher faculties they aim at the preparation for practice; as in the clinic course of the medical schools, in the academical exercises in the juridical faculty, more strongly prominent of late, and in the theological drill. On the other hand, the seminaries have given the philosophical faculties the character of schools of scientific investigation—philological and historical, as well as scientific and mathematical; so that the dissertations come out even from them with a peculiar predominantly scientific character; while the scholastic exercises—the old declamations and disputations—have ceased.

When we ask for the causes of this change, the most decisive of them is found to be the great change which has come over the scientific self-consciousness of the modern world since the seventeenth century. The whole scientific course of the middle ages and down to the sixteenth century was the result of the presumption that knowledge was created in antiquity and was complete. Aristotle especially was regarded as the highest authority in matters of science; he was the philosopher; his writings were the canonical text-books which were transmitted to the universities, expounded and adopted by them. The authority of Aristotle was broken down and the new method founded by Copernicus, Galileo, Kepler, Descartes, Bacon, and Harvey. Science is not now supposed to be complete at hand, but must be created by our labor.

This new method began to penetrate university instruction in the eighteenth century. The young University of Halle first recognized the novel principle of the *libertas philosophandi.* The duty of the university teacher was not to transmit the familiar scholastic philosophy, but to exercise and cultivate independent thinking. The philosophy of Christian Wolff was the first free philosophy found in this school. The scholastic philosophy was supplanted by it in the German universities in the course of the eighteenth century. Its principle is independence in thought: nothing without sufficient reason. The Kantian philosophy began to dispute with it for the mastery at the end of the eighteenth century; but Kant stands, if possible, still more distinctly on the same ground—the ground of independent thought. The view now penetrates the whole of university life that knowledge is not a gift but a duty. The calling of a professor is, in the first place, to labor to produce it; and, second, to train the rising generation to the same work; the university becomes the workshop and nursery of scientific research. This is the view which has gradually gained prevalence in Germany since the last century; and the

men who advance science and form schools constitute the fame of a university. The course in England and France was different from that which matters took in Germany and the countries under German influence. To be high schools for general training has continued till the present time to be the chief end of the English universities, and it was the same in France till the Revolution destroyed the old forms. This condition is connected in part with the fact that in those centralized countries the great scientific institutions in London and Paris answer for the new work of scientific research, while in divided Germany the scientific societies are still relatively unimportant, or have been from the first only annexes of universities, as they all are in fact; and partly with the differences in the internal constitution of the universities, the philosophical faculties having in the western countries almost vanished with the public lectures, and instruction having drawn back into the colleges and assumed within them a scholastic form. Under these influences the entrance of the new philosophy was obstructed. In Germany, on the other hand, the middle-age colleges died out and the philosophical faculties remained with their public instruction, to appear now as the organs with which the new scientific and philosophical life was taken up.

The operation of this change in the scientific world by which university teaching, and especially teaching in the philosophical faculty, was divested of its scholastic features and given a purely scientific character, was supplemented by secondary causes. First among these was the development of the old Latin school into the gymnasium. This change, begun in the second half of the eighteenth century, was completed in the first two decades of the nineteenth century. The present gymnasium differs from the old Latin school by its giving, besides the linguistic and literary course, a course of considerable extent in mathematics, science, history, and geography. Thereby the philosophical faculty departed in a measure from its old work; for the entering student who now comes to the university when about twenty years old, instead of about his eighteenth year, turns at once to the study of his professional branch, with the intention of concluding the necessary scientific training with his abiturient examination. Besides this class the lectures in history, philosophy, and the history of art were heard only by the attendants of the philosophical and theological faculties and occasional guests from the other faculties.

The result was that the philosophical faculty was able and had to change its course of instruction. General and elementary teaching in languages and science was no longer demanded as before. The teacher could presume more, because the pupils brought more with them. A new scientific calling has been

formed in this century—that of the gymnasial professoriate. Hitherto the teacher's office in the Latin schools had been filled entirely with theologians, and was a transition step to the priestly office. The new gymnasium demanded professionals. Its teachers are not candidates in theology with a general philosophical and philological training, but learned philologists, mathematicians, naturalists, and historians, with now professors of modern philology, geography, etc. The introduction of the examination *pro facultate docendi* in Prussia in June, 1870, marked the new demand. The special purpose of the philosophical faculty was from this time on to prepare specialists for teaching in the gymnasia. The philosophical faculty has now adapted its teaching to this new situation, and its purpose has been further so changed, in fact, that aside from the ultimate practical turning of its attendants into the teacher's office, it trains them to be merely learned scientific men. The instruction in the philological, historical, mathematical, and scientific branches is of a kind as if all who took part in it intended to devote themselves to scientific research as their only calling. Justification for this course has been sought in the consideration that recruits for scientific research are in fact found among the attendants; that gymnasium teachers have an important share in scientific work; and, finally, that the object of gymnasium teaching is really preparatory drill to scientific thought, and therefore a strict scientific training is the most important requisite of a German gymnasial teacher.

The priority, the historical course of which is sketched above, appertained to the philosophical faculty, but did not remain limited to it. The theological and juridical faculties had a part in it, and the medical faculty in particular, the course of which runs parallel with that of the philosophical, since it stands in close connection with it through the natural sciences, or as a science is strictly included in it. We are now no longer concerned with the transmission of an established doctrine, but with the search for natural or historical truth; and to approach a participation in this work is now regarded in all the faculties an essential part of the duty of an academical teacher.

When we regard the results of this development, there first appears an extraordinary prosperity of scientific investigation which proceeded in Germany chiefly from the universities. While our people in the seventeenth century stood away behind their western neighbors, they have gained, since the remodeling of the universities in the eighteenth century, a very eminent, in many instances the leading, place in all departments of scientific work. That this is due chiefly to the universities is attested by evidences both at home and abroad. Here scientific investigators have found favorable surroundings for quiet work, the necessary ex-

ternal means, and the no less necessary recognition of coworkers and youth. Here, again, are afforded in intercourse with academic youth, motive and opportunity to attract pupils to co-operation and to train successors in the work. The continuity in scientific labor, to which Germany owes a large part of its success in this field, certainly depends chiefly on this association of investigation and teaching at our universities.

How closely the history of science in Germany in the last century is connected with the history of the universities is made plain in the work of Lexis on the German universities, published in 1893, at the instance of the Minister of Worship. Every step forward in research and its permanent interweaving with the regular work is associated with the foundation of new chairs and new institutes at the universities. Most evident is the growth in the extension of the philosophical and medical faculties. Instead of the eight or ten chairs in the philosophical and the two or three in the medical faculty, which were regarded as sufficient in the sixteenth and seventeenth centuries, we have at the middle and smaller as well as at the larger universities three and four times as many, including the extraordinaries, and even six and eight times. The institutes of every kind nearly all date from the last century.

The German people have expended and are expending every year much on their universities. No other people proportionately devotes so large sums to the endowment of its high-school instruction. We may well say that it has not been a fruitless application of capital, and hope that it will not be in the future. The present repute of the German name among the nations of the earth has grown in no small degree out of its universities. It has sometimes been pointed out that the teaching work of the incumbents of some of the chairs—that of Oriental languages, for instance—has been very insignificant; the cost, per head, of the instruction given has been counted up and found to be high; and it has even been proposed to maintain chairs for such specialties only at two of the large universities. Such calculations are niggardly and not just. The existence of a large number of chairs is not of little importance to the permanence of the scientific achievements of the German people in these fields, even though we are not a wealthy people. The few thousand marks which are paid to the merit of men like Rückert and Bopp ought not to be regarded by any one as wasted, even though their work were substantially null. The university chair in Germany is at the same time a form of endowment for scientific labor. It is the external stimulus to strive for distinction in a kind of work which has at present no marketable value, and makes it possible to devote one's self to it permanently. If it produces work of inferior money value, in what field does not such work slip in?

When we inquire into the consequences of this situation to teaching, we begin to ask whether our universities have not declined as institutes for instruction; whether there is not danger, at least, that teaching will suffer from its combination with research; whether the professors are not disposed to neglect it in their zeal for investigation; and whether they are not too much inclined to draw their students to that side, with the result that the training for practical occupations is shortened. Are not our teachers and pastors, our jurists and officers, and even our doctors, too much devoted to theorizing and doctrine, and too little to life and reality; and do they not acquire this habit at the university? Are they not led by their teachers and by the customs into an exaggerated valuation of pure scientific work? And do not many come to regard practical work as something inferior, which they take up as a means of support only while the more distinguished career of the academy is for some cause inaccessible to them?

Fears of this kind, which are often expressed, are possibly not without ground; but I have another result to present of the association of research and teaching at our universities. I have already referred to it in an essay on the Nature of the German Universities, and content myself now with the repetition of two remarks made there: "According to the German idea the university professor is both a teacher and a scientific investigator, principally the latter, so that one may truly say that in Germany scientific investigators are at the same time the teachers of academic youth. This fixes the position of scientific men in the life of the German people. Our thinkers and investigators are known to us not merely from their writings, but face to face, as personal teachers. Men like Fichte, Schelling, Hegel, and Schleiermacher labored during their lives before the public as teachers. So Kant, Christian Wolff, Heyne, and F. A. Wolf, as personal teachers of our people, trained its leaders and teachers. . . . The relation is undoubtedly advantageous to both. The German youth, who at the university come into immediate contact with the intellectual leaders of the people, receive there the deepest and most enduring stimulus. On the other side, the relation is delightful to our scientific men. They continue young in contact with youth; the personal exchange of thought acquires something moving and vivifying through the silent but intelligent reaction of the students which is lacking to the solitary writer. And if knowledge stands nearer to the hearts of the public in Germany than with other people, that also is connected with the fact that here the great men of science have always been, too, the personal teachers of the young men."

I think there are advantages which may well compensate us for the few embarrassments and disadvantages that may arise

from the combination of teaching and research. Should it occasionally really happen that an academical teacher interested in his scientific research should not pursue his teaching with due diligence, we should not therefore surrender a relation that has been developed among us by historical growth. We should not overlook the fact that in the long run the men most active in research are likewise the best teachers we can get. Exceptions may be adduced by which it may appear that some very eminent men of science have had no inclination or knack for teaching. But it is still true, on the whole, that the heart for research and the heart for teaching are intimately related, and therefore, as a rule, appear together. The testimony of history leaves no doubt that the strongest influences upon the training of youth have till now been exerted by those who have at the same time had leading positions in the scientific world. I call to mind at this moment Kant and Schleiermacher, to whose names a long list might be added from all the faculties, who would confirm the principle that scientific activity and the talent for teaching run parallel with one another.

No more, on the other hand, should we fear that an excess of scientific training is of itself dangerous to students—that is, that it will interfere with their practical career. It is rather true as to this point in general that the more fundamental the scientific training, and the greater the interest in science which any one acquires at the university, the better is he prepared for practical life. It may, indeed, happen that interest will be weakened in a profession neglected on account of engagement in scientific work. This may not rarely occur with the attendants of the philosophical faculty, and the young teacher who has been led to historical, philological, mathematical, or scientific research at the university, and has become interested in them, may feel as if he were not in his right place when he is put over a class of boys to give them elementary instruction, and the work may seem at first insignificant and beneath him. But if he is the right man he will put himself right at once, and his scientific interest will not make his school work a whit harder. On the other hand, if he has time and strength left after his school work (and he must, unless his position imposes an unreasonable burden upon him), he will soon learn how great a treasure he has in a field of occupation which lies outside of his daily routine—like a garden of flowers and herbs outside of the cornfield of his school—in which he can recruit himself after the toil and heat of the day. There is no better protection against falling into listless routine and absorption in the minute interests of the day than continuous participation in scientific work—coming back into the upper story, as a friend of mine who thus varied his daily life was accustomed to describe it. The school will likewise learn how well it is served by teach-

ers of this sort. This is especially true of the gymnasium. The deepest and most lasting effects, as history illustrated in biographies, attests, do not proceed from teachers most eminent in drill and persistence, but from those who lead an inner, intellectual life continuously refreshed and renewed by scientific work. The pupils have a fine appreciation of their teacher and his method. Thorough scholarship and earnest participation in scientific research have assured and always will assure the teacher particular respect in the eyes of his pupils; and many a student has first been inoculated with the taste for the intellectual, inconspicuous though it may have seemed to him, by the view of such a life. It is further true in other learned professions that nothing more firmly fortifies one against the depressing moments that are strange to no calling than a steady interest in science. More than anything else, engagement with concerns of theory operates against the falling into the purely business way of viewing things which apparently threatens to degrade such professions as those of medicine and law.

Thus, we can not see harm of any kind in the direction of university instruction toward scientific research; on the contrary, the purer and deeper the theoretical interest which our students carry into life from the university the better for them and for the business they engage in.

If, however, there is danger—and I believe the fear is not without some foundation—of the power of our universities as teaching institutions declining, we may look for the cause in accompanying conditions. Among these is one existing in direct connection with scientific research—the ever-increasing division of labor and specializing. This is in itself unavoidable. Specializing is here and everywhere a condition of stimulated productiveness. We can not go back to the universality of studies which was possible in antiquity and the middle ages and down into the eighteenth century. With specializing is associated a danger. The splitting up of work into scattering, minute, and often petty study of details weakens the general human interest in science. The immediate interest in knowledge is directed to the whole, to philosophy, from which connected knowledge on all subjects, divine and human, is expected. The long labor of the mind through thousands of years, of which our research is supposed to be the continuation, began with the seeking of the Greeks for a theory of the universe. In the eighteenth century, in the age of Leibnitz, Kant, and Wolff, it was still the object; all scientific work was for a "world-wisdom"—for a view of the nature and meaning of the world and life. Many have now forgotten this, and in the pursuit of little single details have lost sight of the end. Indeed, some are proud of knowing nothing of this; they

deliberately and willfully confine themselves to their special branch, boasting of their independence, and boldly despising what lies beyond their borders. Their scorn is especially expressed toward philosophy; not merely against this or that philosophy, but against philosophy itself, against the seeking for universal knowledge—knowledge of the whole.

This spirit of specialism is the danger. It tends to impede the pursuit of theory; for it is still true that science originally looked not to this or that particular, but to the whole, its nature and its significance. When science ceases to give an answer to these questions, general interest will be turned away from it. Men will then regard research with similar feelings to those with which they look at a sport, in which great exertions are made for a purpose of no value in itself. Is not this feeling sometimes manifested now, even though it is not expressed in words? What means the dissatisfaction with the present shape of our intellectual life, especially with our science, which can not achieve a whole, but wearies itself to exhaustion in endless collection and endless analysis—the indignation against the haughtiness with which the specialist rejects the assistance and even the sympathy and inquiry of the layman, the *dilettante?* In fact, narrowness readily goes with limitation, and conceit with narrowness—that special conceit which thinks itself superior to all because it can see no one in its field besides itself.

Just this spirit of specialism is now dangerous to university teaching, paralyzing the teacher's work and the interest of the learner. At the bottom it is the philosophical in every science that inspires to instructive participation. Man has an innate disposition to propagate his convictions, his view of the world, and his faith. That is the Eros which inspired Socrates to seek intercourse with his pupils. The Eros is wanting to the specialist, along with the philosophical disposition and the love of teaching. To impose a duty of teaching upon him seems to him like a robbery of his precious time. This feeling is responded to by a decline in interest on the part of his hearer. The attraction that draws him is again the philosophical, the humanly significant part of the teaching. Detail and virtuosity and exactness can not take the place of this.

Further, the more the teaching is specialized the less does it give the student what he most needs—a comprehensive survey of the whole of a field of knowledge. Take history: Instead of a lecture on universal history, or the history of the German people, five or ten lectures upon as many fragments or single sides of the subject. Excellent and thorough as they may be in themselves, they afford the beginner less than the others. He most needs the leading direction-lines for the comprehension of the whole, and

these, even if the teacher can and does give them, are less plainly set forth among the mass of details and by being scattered through the hours. Or take natural science and archæology: A hundred years ago a teacher went over the whole subject in a reasonable number of lectures. Now it takes several teachers to do the work, each of whom devotes a course of lectures to a special field. It is evident that this method will make it much harder for the student to get a simple comprehension of the whole. It may easily come to pass that he is bewildered and distracted by the mass of detail, and amid the diversity of views and methods of different teachers gropes unintelligently hither and thither, and does not reach a clear understanding and free view of the whole till after many terms have been wasted. Or, if he seeks to escape this evil by attaching himself to a single teacher, he encounters the other danger of confining himself in that special field, giving himself up to the working out of a single problem, and of soon burying himself in it so deeply that he can see nothing else in heaven and earth, and of ultimately leaving the university a one-sided specialist. Another evil result that occurs to me is, that the increasing division of labor is attended with a loosening of the relation of the university teacher to practical work. This is especially evident in the juridical and theological faculties. The law professors formerly, as members of the bar, regularly took part in the administration of justice. Now they are quite outside of legal practice, and by a reflex action their teaching has become more abstract and dogmatic. The theological professors were formerly engaged also in preaching and pastoral work, and in church and school direction. In the beginning the relation was often such that the pastoral office was regarded as the chief object, and the theological professorship as a secondary work; and the instruction given to the students was a direct introduction to the duties on which they were about to enter.

It should not be forgotten that very earnest and successful efforts have been put forth during the present century to make scientific instruction more fruitful. Among the results of these are the exercises and experiments in seminaries and institutes of various kinds, of which students enjoy the advantages; the increase of means of instruction, such as the more extensive use of demonstrations with which the lectures are accompanied, and the great increase and freer use of libraries, are not to be despised.

After considering all these facts, we conclude that the association of scientific research and scientific teaching, as it has been developed in the history of the German universities, may be regarded as a happy joining, which we should by all means maintain in the future. The universities have so far devoted themselves legitimately to both purposes, and on the whole with good

effect. It is true that the number of students who miss the right way or do not reach the goal is lamentably great. But there is security against this. If any one speaks of it as if it was the fault of the university, and asks it to prevent such failures by discipline, tests of diligence, and more frequent examinations, he makes an unreasonable accusation and presents a demand that can not be complied with. The university is not a school, and will not and can not be one. It is an institution for adults, who live there on their own responsibility. That all its members do not know how to make the best use of their privileges proves nothing against the institution.

Hence we find nothing of an essential character to disturb in the general organization of the university as a teaching institution. We can only endeavor to make its endowments more fruitful and to ward off the harmful tendencies as far as possible. It would indeed be a pity if the institutions which have accomplished so much, and have so illustrious names on their rolls of teachers, should, in these days of minute subdivision of labor, allow their energies to be dissipated in excessive specialization. This is not likely to happen; we may even say it will not happen. There are indications that a reaction is at hand from this tendency. If we mistake not, the one-sided exaltation of the specialist's work has passed its zenith. Long-neglected philosophy is again obtaining a footing even in the domain of scientific research—an evidence that the idea of the unity of knowledge is still vital. What philosophy gains, the university gains as a teaching institution, as the high school of general education.—*A translation, for The Popular Science Monthly, from an article in the Deutsche Rundschau.*

HELMHOLTZ'S TRIBUTE TO HEINRICH HERTZ.

THE preface to the *Prinzipien der Mechanik*, or Principles of Mechanics, of Heinrich Hertz is a testimonial by Helmholtz, who followed the author so soon in death, to his gifts and his work. Endowed with the rarest gifts of genius and character, Hertz, Helmholtz says, had gathered a fullness of fruits almost beyond anticipation, for the winning of which many of his most accomplished fellow-specialists had toiled in vain. It would have been said in classical times that he fell a victim to the envy of the gods. In him Nature and fortune seem to have favored the development of a mind that united in itself all the talents needed for the solution of the most difficult problems of science; a mind adapted alike to the highest keenness and clearness of logical

thinking and to the greatest accuracy in the observation of minute phenomena. He appeared to be destined to disclose to mankind views into many hitherto hidden depths of his nature. I have keenly felt the disappointment of hope caused by his death, for Hertz was the one of my students who entered most fully into my own circle of scientific thoughts and on whom I most confidently relied for their future development. He has by his discoveries secured a permanent fame in science. Not only will his name live through his labors, but his lovely, noble traits of character, his uniform modesty, his glad recognition of the merit of others, the gratitude he felt toward his teacher, will never be forgotten by any who knew him. His only thought was for the truth, which he sought with extreme earnestness and all his might. He was never moved by ambition or self-interest. Even when he had a right to claim discoveries for himself, he was rather inclined to refrain. While usually quiet and taciturn, he could take an animated part in the social circle of his friends, and enliven the conversation by many a pertinent word. He never had a personal adversary, but he could on occasion utter a sharp judgment upon slovenly work or notoriety-seeking efforts that gave themselves out for science. How fully his thoughts embraced the widest views of science is illustrated in this book, the last monument of his earthly effort, in which he has sought to give a consecutive presentation of a system of mechanics consistent in itself, and to deduce all the special laws of that science from a single principle. Great difficulties are indeed still to be overcome in the effort to explain single sections of physics from the principles developed by Hertz. But as a whole his treatise must interest in the highest degree every reader who can enjoy a consistent system of dynamics presented in the most complete and comprehensive mathematical setting.

PITHECOID MAN.

By Prof. E. P. EVANS.

ON the 16th of February, 1894, Prof. Ernst Haeckel, the most eminent representative of natural science and the most ardent advocate of the doctrine of evolution in Germany, celebrated his sixtieth birthday and received the congratulations of numerous friends and pupils from far and near, who in many cases emphasized the expression of their good wishes by the presentation of appropriate gifts. Of these tokens of friendship and esteem perhaps the most suitable, as well as the most striking,

was a painting by Gabriel Max, of Munich, entitled *Pithecanthropus europaeus alalus*. This picture, which formed one of the chief attractions of the International Art Exhibition in the Crystal Palace at Munich, represents the "missing link" and his family, or the primitive semihuman European, as he may have "lived and loved" in the Pliocene period of the Tertiary epoch.

In this connection we may premise that Prof. Gabriel Max is not only a genial artist endowed with a rare power of portraying strong passions and intense emotions of the soul—joy, sorrow, enthusiasm, the ecstasy of the saint and the heroic resignation of the martyr, especially as reflected in the features of women—but also an amateur in anthropology and comparative anatomy. Among his recent works are several remarkable studies of apes, such as In Bad Humor (an angry simian mother correcting her child by pulling its ear), Three Sages (a trio of monkeys sitting before an open book), and especially the semi-satirical group of anthropoids as art critics now in the New Pinakothek at Munich.

Unlike these paintings, which are the result of long and careful observation of living models, the representation of the Pithecanthropus is a fancy sketch based upon scientific deductions from the theory of evolution. The scene lies in the primeval forest, where the female of the pithecoid progenitors of mankind is seated at the foot of a tree, nursing her infant. The hands show a marked advance toward humanity in their differentiation from the feet. Of existing apes the gorilla comes nearest to man in this respect, and is superior to all other quadrumanes in the power of standing erect and walking on its hind feet, but as a rule it goes on all fours. The Pithecanthropus, however, no longer creeps and grovels on the ground, but assumes with ease an upright posture, and, in the words of Racine, "*élève un front noble et regarde les cieux.*" Not only does this creature lift its brow and look at the sky, but, what is perhaps of still greater importance, he puts his foot down like a man, and, if he should chance to leave any "footprints on the sands of time," they would preserve distinct traces of five toes, whereas in the impressions made by the foot of the gorilla we can discover only marks of the ball of the foot and slight indications of the great toe. The same process of development is also perceptible in the formation of the limbs and in the lines of the face. The male, as he stands near the fallen trunk of a tree, has quite straight legs—rather too straight, indeed, for *Homo primigenius*, who was undoubtedly knock-kneed—and the calves are somewhat more fully developed than we should expect to find them in this early stage of transition from ape to man. The hair on the body has become thinner and that of the head has grown longer and more luxuriant, especially in the female. The skull, too, evidently covers a

bigger and better brain than that of the orang-outang or the chimpanzee, and the chest is more human in shape than that of the gibbon. But it is not so much perhaps in these physical changes as in the general cast of the countenance and the peculiar expression of the eye that the variation toward intellectuality and humanity is most clearly reflected. A single tear trembling on the mother's cheek bears witness to the awakening of a kind of consciousness and the stirrings of an emotional nature wholly foreign to the simian breast, and seems a presentiment of all the future woes and miseries of the race. The father's sterner features radiate with paternal pride mingled with a certain thoughtfulness and shadowed by vague anxiety, and, although his susceptibilities are less easily excited and his solicitudes less lively than those of his tender-hearted helpmate, he feels the burden of his responsibilities, lives in the future as well as in the past and present, and already answers to Shakespeare's definition of man as a being that "looks before and after." It is the masterly delineation of these spiritual qualities that reveals the peculiar preeminence of Max as an artist and proves the accuracy of his observations and deductions as an anthropologist. The face of the nursling is invisible, but the shapeliness of the head and the symmetrical proportions of the hands pressing the mother's breast are remarkably human and preclude the possibility of any atavistic reversion in their offspring. Nearly a century ago the German philosopher and psychologist, J. F. Herbart, stated very succinctly the superiority of man's physical structure and constitution in promoting his mental development: "He has hands, he has speech, he lives through a long, helpless infancy." The *Pithecanthropus alalus* fulfills only the first and third of these conditions, but with an additional convolution of the lobes of the brain and a slight modification of the larynx he will acquire the faculty of articulate speech, on which the rapid and progressive growth of the intellectual capacities and moral character so largely depends.

WE often complain, says the report of the American University Extension Society, that the foreigners among us debauch our politics by consenting to serve as mere instruments of designing politicians; but we must remember that these same designing politicians are the only people who have been willing hitherto to give any attention whatever to the political education of these classes of our citizens. The University Extension Society claims to have made the first systematic effort toward helping our foreign-born citizens to qualify themselves for their new position. Courses have been given in quarters of the city (Philadelphia) where recent immigrants have attended them in considerable numbers. "It was pathetic" to observe the eagerness with which audiences of Russian Jews were bent on learning something of the government and institutions of their adopted country.

STUDIES OF CHILDHOOD.

IV.—THE CHILD'S THOUGHTS ABOUT NATURE.

By JAMES SULLY, M. A., LL. D.,
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WE have seen in the previous article how the child-mind behaves when brought face to face with the unknown. We will now examine some of the more interesting results of this early thought-activity, what are known as the characteristic ideas of children. There is no doubt, I think, that children do, by the help of reflection supplementing what they see or otherwise experience and what they are told by others, fashion their own ideas about Nature, death, and the rest. These ideas will probably be proved to vary considerably in the case of different children, yet to preserve throughout these variations a certain general character.

These ideas, moreover, like those of primitive civilized races, will be found to be a crude attempt at a connected system. We must not, of course, expect too much here. The earliest thought of mankind about Nature and the supernatural was very far from being elaborated into a consistent logical whole; yet we can see general forms of conception or tendencies of thought running through the whole. So in the case of this largely spontaneous child-thought. It will disclose to an unsparing critical inspection vast gaps and many unsurmounted contradictions. Thus, in the case of children, as in that of uncultured races, the supernatural realm is at first brought at most into only a very loose connection with the visible world. All the same, there is seen, in the measure of the individual child's intelligence, the endeavor to co-ordinate, and the poor little hard-pressed brain of a child will often pluckily do its best in trying to bring some connection into that congeries of disconnected worlds into which he finds himself so confusingly introduced, partly by the motley character of his own experiences, as the alternations of waking and sleeping, partly by the haphazard miscellaneous instruction, mythological, historical, theological, and the rest, with which we inconsiderately burden his mind.

As was observed in dealing with children's imaginative activity, this primitive childlore, like its prototype in folklore, is largely a product of a naïve vivid fancy. In assigning the relations of things and their reasons the child-mind does not make use of abstract conceptions. It does not talk about "relation," but pictures out the particular relation it wants to express by a figurative expression, as in apperceiving the juxtaposition of

moon and star as mamma and baby. So it does not talk of abstract force, but figures some concrete form of agency, as in explaining the wind by the idea of somebody's waving a big fan somewhere. This first crude attempt of the child to envisage the world is indeed largely mythological, proceeding by the invention of concrete and highly pictorial ideas of fairies, giants, and their doings.

The element of thought comes in with the recognition of the real as such and with the application of the products of young fantasy to comprehending and explaining this reality. And here we see how this primitive child-thought, though it remains instinct with glowing imagery, differentiates itself from pure fancy. This last knows no restraint, and aims only at the delight of its spontaneous playlike movements, whereas thought is essentially the serious work of realizing and understanding what exists. The contrast is seen plainly enough if we consider first the mental attitude of the child when he is frankly romancing, giving out now and again a laugh which shows that he himself fully recognizes the absurdity of his talk; and, secondly, his attitude when in gravest of moods he is calling upon his fancy to aid reason in explaining some puzzling fact. How early this splitting of the child's imaginative activity into these two forms, the playful and the thoughtful, takes place, is not, I think, very easy to determine. Many children at least are apt at first to take all that is told them as gospel. To most children of three and four, I suspect, fairyland, if imagined at all, is as much a reality as the visible world. The disparity of its contents, the fairies, dragons, and the rest, with those of the world of sense does not trouble their mind, the two worlds not being as yet mentally juxtaposed and dovetailed one into the other. It is only later, when the desire to understand overtakes and even passes the impulse to frame bright and striking images, and, as a result of this, critical reflection applies itself to the nursery legends and detects their incongruity with the world of every-day perception, that a clear distinction comes to be drawn between reality and fiction, what exists and can (or might) be verified by sense, and what is only pictured by the mind. When this date is reached, the child's imaginative activity, losing its first *naïveté* and unconsciousness of its own worth, becomes conscious of itself; that is to say, the child, when framing his mental pictures, is aware that he is playing, pretending, or fooling; or, on the other hand, trying to understand things.

With this preliminary peep into the *modus operandi* of children's thought, let us see what sort of ideas of things they fashion.

Beginning with their ideas of natural objects we find, as has been hinted, the influence of certain predominant tendencies. Of

these the more important is the impulse to think of what is far off, whether in space or time, and so unobservable as like what is near and observed. Along with this tendency, or rather as one particular development of it, there goes the disposition, already illustrated, to vivify Nature, to personify things and so to assimilate their behavior to the child's own, and to explain the origin of things by ideas of making and aiming at some purpose. Since at the same time that these tendencies are still dominant the child by his own observation and by such instruction as he gets is gaining insight into the "how," the mechanism of things, we find that his cosmology is apt to be a quaint jumble of the scientific and the mythological. The boy C—— tried to conceive of the divine creation of men as a mechanical process with well-marked stages, the fashioning of the stone men, iron men, and then real men. In many cases we can see that Nature-myth comes in to eke out the deficiencies of mechanical insight. Thus the production of thunder and other strange and inexplicable phenomena is referred, as by the savage and even by many so-called civilized men and women, to the direct interposition of a supernatural agency. The theological idea with which children are supplied shapes itself into that of a capricious and awfully clever demiurgos who not only made the world-machine, but alters its working as often as he likes: for miracle is of the essence of the child's "*Naturanschauung.*" Contradictions are not infrequent, the mythological impulse sometimes alternating with a more distinctly scientific impulse to grasp the mechanical process, as when wind is sometimes thought of as caused by a big fan, and sometimes—e. g., when heard moaning in the night—endowed with life and feeling. In many cases, too, the impulses combine, as when thunder is conceived of as God's action, but effected by mechanical means, such as shooting bricks on to the floor of heaven.

I shall make no attempt to give a methodical account of children's thoughts about Nature. I suspect that a good deal more material will have to be collected before a complete description of these thoughts is possible. I shall content myself with giving a few samples of their ideas so far as my own observations and those of others have thrown light on them.

With respect to the make or substance of things, children are disposed to regard all that they see as having the resistant quality of solid material substance. Just as the infant wants to touch pictures, the reflected sunlight dancing on the wall, and the shadows of objects, so later on the child continues to attribute the resistant quality of body to clouds or other inaccessible contents of the visible scene. Air at rest is of course not perceived by the child, but when in motion as wind it seems, so far as I can ascertain, to be

thought of as substantial; at least this is suggested by the following story from the Worcester collection: A girl aged nine years was looking out and seeing the wind driving the snow in the direction of a particular town, Milbury, whereupon she remarked, "I'd like to live down in Milbury." Asked why, she replied: "There must be a lot of wind down there; it's all blowing that way."

Children are, as may be seen in this story, particularly interested in the movements of things. Movement is the clearest and most impressive manifestation of life. All apparently spontaneous or self-caused movements are accordingly taken by children as by primitive man to be the sign of life, the outcome of something analogous to their own impulses. Hence, the movements of falling leaves, of running water, of feathers, and the like are especially suggestive of life. Some children in the infant department of a London Board School were asked what things in the room were alive, and they promptly replied, the smoke and the fire. Big things moving by an internal mechanism of which the child knows nothing, more especially engines, are of course endowed with life, and the author of The Invisible Playmate tells us that his little girl wanted to stroke the "dear head" of a locomotive.

What is more extraordinary, the child's impulse to give life to many things often leads him to overlook the fact that movement is caused by an external force, and this even when the force is exerted by himself. The boy C——, on finding the cushion he was sitting upon slipping from under him in consequence of his own wriggling movements, pronounced it alive. In like manner children ascribe life to their moving playthings. Thus C——'s sister when five years old stopped one day trundling her hoop, and turning to her mother exclaimed: "Ma, I do think this hoop must be alive, it is so sensible; it goes where I want it to." Another little girl, two years and a quarter old, on having a string attached to a ball put into her hand, and after swinging it round mechanically began to notice the movement of the ball, saying to herself, "Funny ball!" In both these cases, although the movement was directly caused by the child, it was certainly in the first case and apparently in the second attributed to the object. This tendency to attribute self-movement and will to toys survives in the older player. Do we not when playing billiards or bowls catch ourselves talking and thinking of the moving body as having a will of its own, and capable of carrying out our purpose if it only would, and equally capable, alas! of maliciously thwarting it?

Children are disposed, too, to form their own ideas about the mechanism of these spontaneous-looking movements. The examination of the mystery of a mechanical toy may set the young brain trying to construct a whole theory of motion. How far children apply this idea of machinery to their own movements I have not

been able to ascertain. As we shall see, they seem to be mainly occupied with the mystery of our being able to move our limbs when we wish to do so. The idea has occurred to me that children's passion for pulling flowers to pieces may be prompted in part by a vague expectation of finding the mechanical secret of their growth and of the opening and shutting of their petals. Movement plays, I believe, the chief part in children's first ideas of the life of plants, though this idea grows more definite when they get knowledge of their fading and dying.

Next to movement apparently spontaneous sound appears to be a common motive for attributing life to inanimate objects. Are not movement and phonation the two great channels of utterance of the child's own impulses? A little boy assured his teacher that the wind was alive, for he heard it whistling in the night. The ascription of life to fire is greatly aided by the observation of its sputtering, crackling noises. The impulse, too, illustrated in the case given above, to endow so little organic-looking an object as a railway engine with conscious life was probably supported by the knowledge of its puffing and whistling. M. Pierre Loti, when as a child he first saw the sea, regarded it as a living monster, no doubt on the ground of its movement and its noise. The personification of the echo by the child, of which George Sand's reminiscences give an excellent example, as by uncultured man, is a signal illustration of the suggestive force of a voicelike sound.

Closely connected with this impulse to ascribe life to what older people regard as inanimate objects is the tendency to conceive them as growing. This is illustrated in the remark of the boy C—— that his stick would in time grow bigger. On the other hand, there is in the Worcester collection a curious story of a little American boy of three years, who, having climbed up into a large wagon and being asked, "How are you going to get out?" replied, "I can stay here till it gets little and then I can get out my own self." We shall see presently that shrinkage or diminution of size is sometimes attributed by the child-mind to people when getting old. So that we seem to have in each of these cases the extension to things generally of an idea first formed in connection with the observation of human life.

Children's ideas of natural objects are anthropomorphic, not merely as reflecting their own life, but as modeled after the analogy of the effects of human action. Thus I find that they are apt to extend the ideas broken and mended to objects generally. Anything which seems to have become reduced by losing a portion of itself is said to be "broken." A little boy of three years, on seeing the moon partly covered by a cloud, remarked, "The moon is broken." On the other hand, in the case of one little boy everything intact was said to be mended. We can not, of course, infer

from this last that the child thought everything in the world had been broken and mended. He probably had no words for expressing the ideas "make whole" and "keep whole," and so made an analogical use of the familiar word "mend."

So far I have spoken for the most part of children's ideas about near and accessible objects. Their notions of what is distant and inaccessible are, as remarked, wont to be formed on the model of the first. Here, however, their knowledge of things will be largely dependent on others' information, so that the naïve impulse of childish intelligence has, as best it may, to work under the limitations of others' words.

It is perhaps hardly necessary to remind the reader that children's ideas of distance before they begin to travel far are necessarily very inadequate. They are disposed to localize the distant objects they see, as the sun, moon, and stars, and the places they hear about on the earth's surface, as near as possible. The tendency to approximate things, as seen in the infant's stretching out of the hand to touch the moon, lives on in the later impulse to localize the sky and heavenly bodies just beyond the furthest terrestrial object seen, as when a child thought they were just above the church spire; another, that they could be reached by tying a number of ladders together; another, that the setting sun went just behind the ridge of hills, and so forth. The stars, as so much smaller looking, seem to be located further off than the sun and moon. Similarly, when a little Londoner hears of distant places, as Calcutta, he tends to project them just beyond the furthest point known to him, say St. Paul's, to which he was once taken on a long journey from the West End. A child's standard of size and distance is, as all know who have revisited the home of their childhood after many years, very different from the adult's. To the little legs unused as yet to more than short spells of locomotion a mile seems stupendous; and then the small brain can not yet pile up the units of measurement well enough to conceive of hundreds and thousands of miles.

As all who have talked with children know and as inquiries into the contents of the little Boston minds confirm, the child thinks of the world as a circular plain, and of the sky as a sort of inverted bowl upon it—that is to say, he takes them to be what they look. In a similar manner C—— took the sun to be a great disk which could be put on the round globe to make seesaw. Heaven is localized agreeably to what has been said about the tendency to bring things as near as possible, just above the sky, which forms its floor. Some genuine thought-work is shown in the effort to adjust the various things seen and heard of respecting the celestial region into something like a connected whole. Thus the sky is apt to be thought of as *thin*, this idea being probably formed for

the purpose of explaining the shining through of moon and stars. Stars are, as we know, commonly thought of by the child as holes in the sky letting through the light beyond. One Boston child ingeniously applied the idea of the thinness of the sky to explain the appearance of the moon when one half is bright and the other faintly illumined, supposing it to be halfway through the partially diaphanous floor. Others, again, prettily accounted for the waning of the moon to a crescent by saying it was half stuck or half buttoned into the sky.

As with the savage, so with the child, the heavenly bodies seem to be personified spontaneously, and quite independently of theological instruction. A little boy, two years and two months old, sitting on the floor one day in a great temper, looked up and saw the sun shining, and said angrily, "Sun not look at Hennie," and then, when he found this unavailing, "Please, sun, not look at poor Hennie."* Many children seem quite spontaneously to apperceive stars as eyes, and the moon of course as a human face.

The movements of the sun and other heavenly bodies are similarly apperceived by the help of ideas of movements of familiar terrestrial objects. Thus the sun was thought by the Boston children half mythologically, half mechanically, to roll, to fly, to be blown (like a soap bubble or balloon), and so forth. The anthropocentric form of teleological explanation is apt to creep in, as when a Boston child said charmingly that the moon comes round when people forget to light some lamps. Theological ideas, too, are pressed into this sphere of explanation, as when the disappearance of the sun is variously attributed to God's pulling it up higher out of sight, to his taking it into heaven and putting it to bed, and so forth. These ideas are pretty obviously not those of a country child with a horizon. There is rather more of Nature-observation in the idea of another child that the sun after setting lies under the trees, where angels mind it. But I confess that many of these answers of the Boston children look to me more like attempts of vacuous minds to invent something smart on the spur of the moment than spontaneous growths pre-existing before the questioner appears on the scene.

The impressive phenomena of thunder and lightning give rise in the case of the child, as in that of the Nature-man, to some fine myth-making. The American children, as already observed, have different mechanical illustrations for setting forth the *modus* of the supernatural action here, thunder being thought of now as God groaning, now as his walking loud on the floor of heaven (cf. the old Norse idea that thunder is caused by the rolling of Thor's chariot), now as his hammering, now as

* See note by E. M. Stevens, Mind, vol. xi, p. 150.

his having coals run in—ideas which show how naïvely the child-mind envisages the Deity, making him a respectable citizen with a house and a coal cellar. In like manner the lightning is attributed to God's burning the gas quick, striking many matches at once, or other familiar human device for getting a brilliant light suddenly. So rain is let down by God from a cistern by a hose, or, better, through a sieve or a dipper with holes.*

Throughout the whole region of mysterious unexplained and exceptional phenomena we have illustrations of the anthropocentric tendency to regard what takes place as designed for us poor mortals. The little girl of whom Mr. Canton writes thought "the wind and the rain and the moon 'walking' came out to see *her*, and the flowers wake up with the same laudable object." † When frightened by the crash of the thunder a child instinctively thinks that it is all done to vex his little soul. One of the funniest examples of the application of this idea I have met with is in the Worcester collection. Two children, D—— and K——, aged ten and five respectively, live in a small American town. D——, who is reading about an earthquake, addresses his mother thus: "Oh, isn't it dreadful, mamma? Do you suppose we will ever have one here?" K—— (intervening), with the characteristic impulse of the young child to correct its elders, "Why, no, D——, they don't have earthquakes in little towns like this." There is much to unravel in this delightful childish observation. It looks, to my mind, as if the earthquake were envisaged by the little five-year-old as a show, God being presumably the traveling showman, who takes care to display his fearful wonders only where there is an adequate body of spectators.

Finally, the same impulse to understand the new and strange by assimilating it to the familiar is, so far as I can gather, seen in children's first ideas about those puzzling semblances of visible objects which are due to subjective sensations. To judge from C——'s case, the bright spectra or after-images caused by looking at the sun are instinctively objective—that is, regarded as things external to his body. Here is a pretty full account of a child's thought about these subjective optical phenomena: A little boy of five years, in rather poor health at the time, "constantly imagined he saw angels, and said they were not white, that was a mistake, they were little colored things, light and beautiful, and they went into the toy basket and played with his toys." Here we have not only objectifying but myth-building. A year later he re-

* I am greatly indebted here as in other places to Dr. Stanley Hall's well-known article on The Contents of Children's Minds, published in the Princeton Review.

† The Invisible Playmate, pp. 27, 28.

turned to the subject. "He stood at the window at B——, looking out at a sea mist thoughtfully, and said suddenly: 'Mamma, do you remember I told you that I had seen angels? Well, I want now to say they were not angels, though I thought they were. I have seen it often lately, I see it now: it is bright stars, small bright stars moving by. I see it in the mist before that tree. I see it oftenest in the misty days. . . . Perhaps by and by I shall think it is something in my own eyes." Here we see a long and painstaking attempt of a child's brain to read a meaning into the "flying spots" which many of us know, though we hardly give them a moment's attention.

What are children's first thoughts about their dreams like? I have not been able to collect much evidence on this head. What seems certain is that to the naïve intelligence of the child these counterfeits of ordinary sense-presentations are real external things. The crudest manifestation of this thought-tendency is seen in taking the dream apparition to be actually present in the bedroom. A boy in an elementary school in London, aged five years, said one day, "Teacher, I saw an old woman one night against my bed." Another child, a little girl, in the same school, told her mother that she had seen a funeral last night, and on being asked "Where?" answered quaintly, "I saw it in my pillow." A little boy, whom I know, once asked his mother not to put him to bed in a certain room "because there were so many dreams in the room." In thus materializing the dream and localizing it in the actual surroundings, the child but reflects the early thought of the race which starts from the supposition that the man or animal which appears in a dream actually approaches the sleeper.

The Nature-man, as we know from Prof. Tylor's researches, goes on to explain dreams by his theory of souls or "doubles" ("animism"). Children do not often find their way to so subtle a line of thought. Much more commonly they pass from the first stage of naïve acceptance of objects as present here and now to the identification of dreamland with fairyland or the other and invisible world. There is little doubt that the imaginative child firmly believes in the existence of this invisible world, keeps it carefully apart from this one, even though at times he may give it a definite locality in this—e. g., in C——'s case, in the wall of his bedroom. He gets access to it by shutting out the real world, as when he closes his eyes tightly and "thinks." With such a child dreams get taken up into the invisible world. Going to sleep is now recognized as the surest way of passing into this region. The varying color of his dreams, now bright and dazzling in their beauty, now black and terrifying, is explained by a reference to the division of that fairy world into princes and good

fairies, on the one hand, and cruel giants, witches, and the like, on the other hand.

We may now pass to some of children's characteristic ideas about living things, more particularly human beings and the familiar domestic animals. The most interesting of these, I think, are those respecting growth and birth.

As already mentioned, growth is one of the most stimulating of childish puzzles. A child finds that things are in general made bigger by additions from without, and his earliest conception of growth is, I think, that of such addition. Thus plants are made to grow—that is, swell out—by the rain. The idea that the growth or expansion of animals comes from eating is easily reached by the childish intelligence, and, as we know, nurses and parents have a way of recommending the less attractive sorts of diet by telling children that they will make them grow. The idea that the sun makes us grow, often suggested by parents (who may be ignorant of the fact that growth is more rapid in the summer than in the winter), is probably interpreted by the analogy of an infusion of something into the body.

In carrying out my inquiries into this region of childish ideas I lighted quite unexpectedly on the queer notion that toward the end of life there is a reverse process of shrinkage. Old people are supposed to become little again. The first instance of this was supplied me by the Worcester collections of Thoughts. A little girl of three once said to her mother, "When I am a big girl, and you are a little girl, I shall whip you just as you whipped me now." At first one is almost disposed to think that this child must have heard of Mr. Anstey's amusing story Vice Versa. Yet this idea seems too improbable, and I have since found that she is not by any means the only one who has entertained this idea. A little boy that I know, when about three years and a half old, used often to say to his mother with perfect seriousness of manner, "When I am big then you will be little; then I will carry you about and dress you and put you to sleep."

I happened to mention this fact at a meeting of mothers and teachers, when I received further evidence of this tendency of child-thought. One lady whom I know could recollect quite clearly that when a little girl she was promised by her aunt some valuables—trinkets, I fancy—when she grew up, and that she at once turned to her aunt and promised her that she would then give her in exchange all her dolls, as by that time she (the aunt) would be a little girl. Another case narrated was that of a little girl of three years and a half who, when her elder brother and sister spoke to her about her getting big, rejoined, "What will you do when you are little?" A third case mentioned was that of a child asking about some old person of her acquaintance,

"When will she begin to get small?" I have since obtained corroboratory instances from parents and teachers of infant classes.

Here we seem to have to do with a pure product of the childish brain. What does it mean? By what quaint zigzag movement of child-thought, by the use of what far-fetched analogy, was the idea excogitated? I can not learn that there is any idea like it in primitive folklore. This at once suggests that it is the result of the activity of the little brain as employed in deciphering the words of older people. It has been suggested to me that the playful way a nurse will sometimes adopt of speaking to the child when she wants it to do something—e. g., "When I'm a little girl I shall be good and not mess my clothes"—may be taken literally by the serious mind of the child. I do not, however, think that this will account for the frequency of the phenomenon. It seems probable that other processes of childish interpretation assist. Children often hear old people talked about as weak and silly. Now, if there is one proposition of which the child is sure it is that grown people are always able to do things and awfully knowing. C——'s belief in the preternatural calculating powers of Goliath shows how strongly the child-mind associates size and intelligence. Consequently, it is a shock to a child to overhear his mother talking about grown people as stupid, just as it is a shock to him to hear her characterizing them as bad or wicked. The creed of infancy is that all such defects will disappear with completion of growth. Hence it may be that children who are in the way of hearing old people spoken of as losing power and intelligence carry over the thought of littleness, and imagine that they must be getting small again. This tendency would, of course, be greatly strengthened if the child happened to hear an old person talked about as getting childish or passing into second childhood. Indeed, I am disposed to think, from the frequency of the appearance of the belief, that this reference to the childish condition of old age is probably always co-operant in bringing the tendency to the definiteness of a theory of senility. However the idea arises, it is a curious and striking illustration of the fact that with all our attempts to supply the young brain with our own ideas, it manages to substitute a good many new and thoroughly original ones.

The origin of babies and young animals furnishes, as we know, the child's brain with much food for speculation. Here the little thinker is not often left to excogitate a theory for himself. His inconvenient questionings in this direction have to be firmly checked, and various and truly wonderful are the ways in which the nurse and the mother are wont to do this. Any fiction is supposed to be good enough for the purpose. Divine action is

commonly called in, the questioner being told that the baby has been sent down from heaven in the arms of an angel, etc. Fairy stories with their pretty conceits, as that of the child Thumbkin growing out of a flower, in Andersen's book, contribute their suggestions, and so there arises a mass of child lore about babies in which we can see that the main ideas are supplied by others, though now and then we catch a glimpse of the child's own contributions. Thus, according to Dr. Stanley Hall's report, the Boston children said, among other things, that God makes babies in heaven, lets them down or drops them for the women and doctors to catch them, or that he brings them down a wooden ladder backward and pulls it up again, or that mamma and nurse or doctor goes up and fetches them in a balloon. They are said by some to grow in cabbages, or to be placed by God in water, perhaps in the sewer, where they are found by the doctor, who takes them to sick folks that want them. Here we have delicious touches of child fancy, quaint adaptations of fairy and Bible lore, as in the use of Jacob's ladder and of the legend of Moses placed among the bulrushes, this last being enriched by a thorough master stroke of child genius—the idea of the dark, mysterious, wonder-producing sewer. In spite, too, of all that others do to impress the traditional notions of the nursery here, we find that a child will now and again think out the whole subject for himself. The little boy C—— is not the only one, I find, who is of the opinion that babies are got at a shop. Another little boy, I am informed, once asked his mamma, in the abrupt, childish manner, "Mamma, vere did Tommy (his one name) tum (come) from ?" and then, with the equally childish way of sparing you the trouble of answering his question, himself answered it quite to his own satisfaction, "Mamma did tie (buy) Tommy in a s'op (shop)." This looks like a real childish idea. To the young imagination the shop is a veritable wonderland, an El Dorado of valuables; and it appears quite reasonable to the childish intelligence that babies, like dolls and other treasures, should be procurable there.

The ideas, partly communicated by others, partly thought out for themselves, are carried over into the beginnings of animal life. Thus, as we have seen, one little boy supposed that God "helps pussy to have 'ickle kitties, seeing that she hasn't any kitties in eggs given her to sit upon."

ENUMERATING the climatic influences of forests, Prof. I. B. Balfour showed, in the British Association, that they improve the soil drainage and modify miasmatic conditions. Trees, like green plants, assimilate carbon and purify the air, but it is not established that forests increase ozone. They stop air currents laden with dust particles and germs; they prevent extremes of temperature; they increase humidity, precipitate rain, and control waterflow.

THE ECONOMIC THEORY OF WOMAN'S DRESS.

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IN human apparel the element of dress is readily distinguishable from that of clothing. The two functions—of dress and of clothing the person—are to a great extent subserved by the same material goods, although the extent to which the same material serves both purposes will appear very much slighter on second thought than it does at first glance. A differentiation of materials has long been going on, by virtue of which many things that are worn for the one purpose no longer serve, and are no longer expected to serve, the other. The differentiation is by no means complete. Much of human apparel is worn both for physical comfort and for dress; still more of it is worn ostensibly for both purposes. But the differentiation is already very considerable and is visibly progressing.

But, however united in the same object, however the two purposes may be served by the same material goods, the purpose of physical comfort and that of a reputable appearance are not to be confounded by the meanest understanding. The elements of clothing and of dress are distinct; not only that, but they even verge on incompatibility; the purpose of either is frequently best subserved by special means which are adapted to perform only a single line of duty. It is often true, here as elsewhere, that the most efficient tool is the most highly specialized tool.

Of these two elements of apparel dress came first in order of development, and it continues to hold the primacy to this day. The element of clothing, the quality of affording comfort, was from the beginning, and to a great extent it continues to be, in some sort an afterthought.

The origin of dress is sought in the principle of adornment. This is a well-accepted fact of social evolution. But that principle furnished the point of departure for the evolution of dress rather than the norm of its development. It is true of dress, as of so much else of the apparatus of life, that its initial purpose has not remained its sole or dominant purpose throughout the course of its later growth. It may be stated broadly that adornment, in the *naïve* æsthetic sense, is a factor of relatively slight importance in modern dress.

The line of progress during the initial stage of the evolution of apparel was from the simple concept of adornment of the person by supplementary accessions from without, to the complex concept of an adornment that should render the person pleasing, or of an enviable presence, and at the same time serve to indicate the pos-

session of other virtues than that of a well-favored person only. In this latter direction lies what was to evolve into dress. By the time dress emerged from the primitive efforts of the savage to beautify himself with gaudy additions to his person, it was already an economic factor of some importance. The change from a purely æsthetic character (ornament) to a mixture of the æsthetic and economic took place before the progress had been achieved from pigments and trinkets to what is commonly understood by apparel. Ornament is not properly an economic category, although the trinkets which serve the purpose of ornament may also do duty as an economic factor, and in so far be assimilated to dress. What constitutes dress an economic fact, properly falling within the scope of economic theory, is its function as an index of the wealth of its wearer—or, to be more precise, of its owner, for the wearer and owner are not necessarily the same person. It will hold with respect to more than one half the values currently recognized as "dress," especially that portion with which this paper is immediately concerned—woman's dress—that the wearer and the owner are different persons. But while they need not be united in the same person, they must be organic members of the same economic unit; and the dress is the index of the wealth of the economic unit which the wearer represents.

Under the patriarchal organization of society, where the social unit was the man (with his dependents), the dress of the women was an exponent of the wealth of the man whose chattels they were. In modern society, where the unit is the household, the woman's dress sets forth the wealth of the household to which she belongs. Still, even to-day, in spite of the nominal and somewhat celebrated demise of the patriarchal idea, there is that about the dress of women which suggests that the wearer is something in the nature of a chattel; indeed, the theory of woman's dress quite plainly involves the implication that the woman is a chattel. In this respect the dress of women differs from that of men. With this exception, which is not of first-rate importance, the essential principles of woman's dress are not different from those which govern the dress of men; but even apart from this added characteristic the element of dress is to be seen in a more unhampered development in the apparel of women. A discussion of the theory of dress in general will gain in brevity and conciseness by keeping in view the concrete facts of the highest manifestation of the principles with which it has to deal, and this highest manifestation of dress is unquestionably seen in the apparel of the women of the most advanced modern communities.

The basis of the award of social rank and popular respect is the success, or more precisely the efficiency, of the social unit, as evidenced by its visible success. When efficiency eventuates in

possessions, in pecuniary strength, as it eminently does in the social system of our time, the basis of the award of social consideration becomes the visible pecuniary strength of the social unit. The immediate and obvious index of pecuniary strength is the visible ability to spend, to consume unproductively; and men early learned to put in evidence their ability to spend by displaying costly goods that afford no return to their owner, either in comfort or in gain. Almost as early did a differentiation set in, whereby it became the function of woman, in a peculiar degree, to exhibit the pecuniary strength of her social unit by means of a conspicuously unproductive consumption of valuable goods.

Reputability is in the last analysis, and especially in the long run, pretty fairly coincident with the pecuniary strength of the social unit in question. Woman, primarily, originally because she was herself a pecuniary possession, has become in a peculiar way the exponent of the pecuniary strength of her social group; and with the progress of specialization of functions in the social organism this duty tends to devolve more and more entirely upon the woman. The best, most advanced, most highly developed societies of our time have reached the point in their evolution where it has (ideally) become the great, peculiar, and almost the sole function of woman in the social system to put in evidence her economic unit's ability to pay. That is to say, woman's place (according to the ideal scheme of our social system) has come to be that of a means of conspicuously unproductive expenditure.

The admissible evidence of the woman's expensiveness has considerable range in respect of form and method, but in substance it is always the same. It may take the form of manners, breeding, and accomplishments that are, *prima facie*, impossible to acquire or maintain without such leisure as bespeaks a considerable and relatively long-continued possession of wealth. It may also express itself in a peculiar manner of life, on the same grounds and with much the same purpose. But the method in vogue always and everywhere, alone or in conjunction with other methods, is that of dress. "Dress," therefore, from the economic point of view, comes pretty near being synonymous with "display of wasteful expenditure."

The extra portion of butter, or other unguent, with which the wives of the magnates of the African interior anoint their persons, beyond what comfort requires, is a form of this kind of expenditure lying on the border between primitive personal embellishment and incipient dress. So also the brass-wire bracelets, anklets, etc., at times aggregating some thirty pounds in weight, worn by the same class of persons, as well as, to a less extent, by the male population of the same countries. So also the pelt of the arctic fur seal, which the women of civilized countries prefer to

fabrics that are preferable to it in all respects but that of expense. So also the ostrich plumes and the many curious effigies of plants and animals that are dealt in by the milliners. The list is inexhaustible, for there is scarcely an article of apparel of male or female, civilized or uncivilized, that does not partake largely of this element, and very many may be said, in point of economic principle, to consist of virtually nothing else.

It is not that the wearers or the buyers of these wasteful goods desire the waste. They desire to make manifest their ability to pay. What is sought is not the *de facto* waste, but the appearance of waste. Hence there is a constant effort on the part of the consumers of these goods to obtain them at as good a bargain as may be; and hence also a constant effort on the part of the producers of these goods to lower the cost of their production, and consequently to lower the price. But as fast as the price of the goods declines to such a figure that their consumption is no longer *prima facie* evidence of a considerable ability to pay, the particular goods in question fall out of favor, and consumption is diverted to something which more adequately manifests the wearer's ability to afford wasteful consumption.

This fact, that the object sought is not the waste but the display of waste, develops into a principle of pseudo-economy in the use of material; so that it has come to be recognized as a canon of good form that apparel should not show lavish expenditure simply. The material used must be chosen so as to give evidence of the wearer's (owner's) capacity for making it go as far in the way of display as may be; otherwise it would suggest incapacity on the part of the owner, and so partially defeat the main purpose of the display. But what is more to the point is that such a mere display of crude waste would also suggest that the means of display had been acquired so recently as not to have permitted that long-continued waste of time and effort required for mastering the most effective methods of display. It would argue recent acquisition of means; and we are still near enough to the tradition of pedigree and aristocracy of birth to make long-continued possession of means second in point of desirability only to the possession of large means. The greatness of the means possessed is manifested by the volume of display; the length of possession is, in some degree, evidenced by the manifestation of a thorough habituation to the methods of display. Evidence of a knowledge and habit of good form in dress (as in manners) is chiefly to be valued because it argues that much time has been spent in the acquisition of this accomplishment; and as the accomplishment is in no wise of direct economic value, it argues pecuniary ability to waste time and labor. Such accomplishment, therefore, when possessed in a high degree, is evidence of a life (or of more than

one life) spent to no useful purpose; which, for purposes of respectability, goes as far as a very considerable unproductive consumption of goods. The offensiveness of crude taste and vulgar display in matters of dress is, in the last analysis, due to the fact that they argue the absence of ability to afford a reputable amount of waste of time and effort.

Effective use of the means at hand may, further, be taken to argue efficiency in the person making the display; and the display of efficiency, so long as it does not manifestly result in pecuniary gain or increased personal comfort, is a great social desideratum. Hence it happens that, surprising as it may seem at first glance, a principle of pseudo-economy in the use of materials has come to hold a well-secured though pretty narrowly circumscribed place in the theory of dress, as that theory expresses itself in the facts of life. This principle, acting in concert with certain other requirements of dress, produces some curious and otherwise inexplicable results, which will be spoken of in their place.

The first principle of dress, therefore, is conspicuous expensiveness. As a corollary under this principle, but of such magnificent scope and consequence as to claim rank as a second fundamental principle, there is the evidence of expenditure afforded by a constant supersession of one wasteful garment or trinket by a new one. This principle inculcates the desirability, amounting to a necessity wherever circumstances allow, of wearing nothing that is out of date. In the most advanced communities of our time, and so far as concerns the highest manifestations of dress—e. g., in ball dress and the apparel worn on similar ceremonial occasions, when the canons of dress rule unhampered by extraneous considerations—this principle expresses itself in the maxim that no outer garment may be worn more than once.

This requirement of novelty is the underlying principle of the whole of the difficult and interesting domain of fashion. Fashion does not demand continual flux and change simply because that way of doing is foolish; flux and change and novelty are demanded by the central principle of all dress—conspicuous waste.

This principle of novelty, acting in concert with the motive of pseudo-economy already spoken of, is answerable for that system of shams that figures so largely, openly and aboveboard, in the accepted code of dress. The motive of economy, or effective use of material, furnishes the point of departure, and this being given, the requirement of novelty acts to develop a complex and extensive system of pretenses, ever varying and transient in point of detail, but each imperative during its allotted time—facings, edgings, and the many (pseudo) deceptive contrivances that will occur to any one that is at all familiar with the technique of dress. This pretense of deception is often developed into a pathetic, child-

like make-believe. The realities which it simulates, or rather symbolizes, could not be tolerated. They would be in some cases too crudely expensive, in others inexpensive and more nearly adapted to minister to personal comfort than to visible expense; and either alternative is obnoxious to the canons of good form.

But apart from the exhibition of pecuniary strength afforded by an aggressive wasteful expenditure, the same purpose may also be served by conspicuous abstention from useful effort. The woman is, by virtue of the specialization of social functions, the exponent of the economic unit's pecuniary strength, and it consequently also devolves on her to exhibit the unit's capacity to endure this passive form of pecuniary damage. She can do this by putting in evidence the fact (often a fiction) that she leads a useless life. Dress is her chief means of doing so. The ideal of dress, on this head, is to demonstrate to all observers, and to compel observation of the fact, that the wearer is manifestly incapable of doing anything that is of any use. The modern civilized woman's dress attempts this demonstration of habitual idleness, and succeeds measurably.

Herein lies the secret of the persistence, in modern dress, of the skirt and of all the cumbrous and otherwise meaningless drapery which the skirt typifies. The skirt persists because it is cumbrous. It hampers the movements of the wearer and disables her, in great measure, for any useful occupation. So it serves as an advertisement (often disingenuous) that the wearer is backed by sufficient means to be able to afford the idleness, or impaired efficiency, which the skirt implies. The like is true of the high heel, and in less degree of several other features of modern dress.

Herein is also to be sought the ground of the persistence (probably not the origin) of the one great mutilation practiced by civilized Occidental womankind—the constricted waist, as well as of the analogous practice of the abortive foot among their Chinese sisters. This modern mutilation of woman is perhaps not to be classed strictly under the category of dress; but it is scarcely possible to draw the line so as to exclude it from the theory, and it is so closely coincident with that category in point of principle that an outline of the theory would be incomplete without reference to it.

A corollary of some significance follows from this general principle. The fact that voluntarily accepted physical incapacity argues the possession of wealth practically establishes the futility of any attempted reform of woman's dress in the direction of convenience, comfort, or health. It is of the essence of dress that it should (appear to) hamper, incommode, and injure the wearer, for in so doing it proclaims the wearer's pecuniary ability to endure idleness and physical incapacity.

It may be noted, by the way, that this requirement, that women must appear to be idle in order to be respectable, is an unfortunate circumstance for women who are compelled to provide their own livelihood. They have to supply not only the means of living, but also the means of advertising the fiction that they live without any gainful occupation; and they have to do all this while encumbered with garments specially designed to hamper their movements and decrease their industrial efficiency.

The cardinal principles of the theory of woman's dress, then, are these three:

1. Expensiveness: Considered with respect to its effectiveness as clothing, apparel must be uneconomical. It must afford evidence of the ability of the wearer's economic group to pay for things that are in themselves of no use to any one concerned—to pay without getting an equivalent in comfort or in gain. From this principle there is no exception.

2. Novelty: Woman's apparel must afford *prima facie* evidence of having been worn but for a relatively short time, as well as, with respect to many articles, evidence of inability to withstand any appreciable amount of wear. Exceptions from this rule are such things as are of sufficient permanence to become heirlooms, and of such surpassing expensiveness as normally to be possessed only by persons of superior (pecuniary) rank. The possession of an heirloom is to be commended because it argues the practice of waste through more than one generation.

3. Ineptitude: It must afford *prima facie* evidence of incapacitating the wearer for any gainful occupation; and it should also make it apparent that she is permanently unfit for any useful effort, even after the restraint of the apparel is removed. From this rule there is no exception.

Besides these three, the principle of adornment, in the æsthetic sense, plays some part in dress. It has a certain degree of economic importance, and applies with a good deal of generality; but it is by no means imperatively present, and when it is present its application is closely circumscribed by the three principles already laid down. Indeed, the office of the principle of adornment in dress is that of handmaid to the principle of novelty, rather than that of an independent or co-ordinate factor. There are, further, minor principles that may or may not be present, some of which are derivatives of the great central requisite of conspicuous waste; others are of alien origin, but all are none the less subject to the controlling presence of the three cardinal principles enumerated above. These three are essential and constitute the substantial norm of woman's dress, and no exigency can permanently set them aside so long as the chance of rivalry between

persons in respect of wealth remains. Given the possibility of a difference in wealth, and the sway of this norm of dress is inevitable. Some spasm of sense, or sentiment, or what not, may from time to time create a temporary and local diversion in woman's apparel; but the great norm of "conspicuous waste" can not be set aside or appreciably qualified so long as this its economic ground remains.

To single out an example of the temporary effect of a given drift of sentiment, there has, within the past few years, come, and very nearly gone, a recrudescence of the element of physical comfort of the wearer, as one of the usual requirements of good form in dress. The meaning of this proposition, of course, is not what appears on its face; that seldom happens in matters of dress. It was the show of personal comfort that was lately imperative, and the show was often attained only at the sacrifice of the substance. This development, by the way, seems to have been due to a ramification of the sentimental athleticism (flesh-worship) that has been dominant of late; and now that the crest of this wave of sentiment has passed, this alien motive in dress is also receding.

The theory of which an outline has now been given is claimed to apply in full force only to modern woman's dress. It is obvious that if the principles arrived at are to be applied as all-deciding criteria, "woman's dress" will include the apparel of a large class of persons who, in the crude biological sense, are men. This feature does not act to invalidate the theory. A classification for the purpose of economic theory must be made on economic grounds alone, and can not permit considerations whose validity does not extend beyond the narrower domain of the natural sciences to mar its symmetry so far as to exclude this genial volunteer contingent from the ranks of womankind.

There is also a second, very analogous class of persons, whose apparel likewise, though to a less degree, conforms to the canons of woman's dress. This class is made up of the children of civilized society. The children, with some slight reservation of course, are, for the purpose of the theory, to be regarded as ancillary material serving to round out the great function of civilized womankind as the conspicuous consumers of goods. The child in the hands of civilized woman is an accessory organ of conspicuous consumption, much as any tool in the hands of a laborer is an accessory organ of productive efficiency.

EXPERIMENTS to determine whether air when dried became electrified, reported upon by Lord Kelvin in the British Association, were interpreted as indicating that the effect was really due, not to bubbling or other motion that might cause friction, but to true electrification of the vapor in the air.

SHINTŌ, THE OLD RELIGION OF JAPAN.

By NOBUTA KISHIMOTO, M. A.

DURING the last twenty years there has been considerable discussion in Japan, both among native and foreign scholars, concerning the real nature of Shintō, the old religion of that country, and this discussion seems to have revolved around two central questions, namely, whether Shintō is a religion or not, and whether it was native to Japan or not. Different answers have been given, and diverse views have been expressed. However, the question whether Shintō was native to Japan or not largely depends upon what do we mean by Shintō, just as the question whether Shintō is a religion or not, depends upon just what we mean by religion. Shintō can not be a religion in the sense that Buddhism, Christianity, and Mohammedanism are, for it has neither code of morals nor system of beliefs, as these systems have. But if we are justified in saying that the rude Hebrews of the pre-Mosaic ages had their religion, and the wandering Arabs of the ante-Mohammedan centuries also had theirs, in this sense at least there can be nothing improper in the statement that our early forefathers too had their own religion, known later in history as Shintō.

What is Shintō, then? one may ask. What does its name mean? How old is it? What is its history? Is the present Shintō different from its primitive form? What will be the best method for investigating it? To answer all these questions with any degree of fullness is not the intention of the present writing —indeed, is not possible in such a paper as this. But the writer will venture to answer some of the above questions by presenting certain results of his personal experiences and investigations regarding this old and yet living religion of his native country.

The name Shintō consists of the two Chinese words *shin* and *tō*. The word *shin* may be either a noun or an adjective, as many *Chinese* words are. As a noun it means *god* or *gods*, and as an adjective it means *divine*. The word *tō* is the same word with the *taou* of Taouism, and means primarily *way* or *path*, and secondarily *teaching* or *doctrine*. This is the word by which the *Logos* of the Gospel according to St. John is rendered in both the Chinese and Japanese versions of the New Testament. Thus, taken by itself, the name Shintō may mean several different things, but as it is applied to the old religion of Japan its meaning is quite definite, and can not but be the "way of the gods." We know that the term *shin* is plural from the fact that the gods of Shintō are very numerous, and also we know the term *tō* is singular from the fact that Shintō as a religion is but one.

Some writers spell the name *Shintō*, as it is spelled here, and others spell it without *h* and write *Sintō*. Either form is practically good, but strictly speaking neither is correct, for the Japanese tongue does not distinguish the two syllables *shi* and *si*, its corresponding sound being something halfway between the two. By some writers this word is written also Shintō*ism*. The addition of the suffix *ism* has this practical advantage—it gives a clew to the category to which the thing denoted by the word belongs. On the other hand, it makes the word tautological, and hence is not used here. One may ask, Then, is the name Taou*ism* tautological? Certainly not, for there the word *taóu* or *tō* is used in that particular sense which is well known to those who are familiar with the teaching of the founder of that system.

I have just said that the name Shintō consists of two *Chinese* —not *Japanese*—words, and hence the origin of this name can not be regarded as native to Japan. But here let me emphasize—because I know there are some foreign scholars who have made the mistake—the fact that the Chinese origin of the *name* Shintō by no means implies the Chinese origin of the *thing* indicated by it. Buddhism had already existed for some time before it received its name. Christianity existed before it began to be called by its name. So, after these analogies, we might just as well say that there was the thing Shintō existing before its name was applied to it. The earliest mention of the name Shintō, so far as I know, is found in the *Nihongi*, the Chronicles of Japan, which was completed in the year 720 A. D. Before the introduction of Confucianism and Buddhism the religion of Japan had no need of being called by any name. But when these foreign systems made their appearance and began to spread, there came, it seems, the necessity of calling the native faith by a particular name by way of distinction. In Japan, Buddhism was called *Butsu-dō*, the "way of the Buddhas," and Confucianism, *Ju-dō*, the "way of the sages." To contrast with these, the native religion probably began to be called *Shin-tō*, the "way of the gods," the *dō* of the two former names being the same word with the *tō* of the last, only differently pronounced for euphony. At what particular time this happened we have no means of knowing. The name is not found in the oldest extant book of the Japanese language, called *Kojiki*, the Records of Ancient Matters, which was completed eight years before the Nihongi—that is, 712 A. D.; but as we have already in the Constitution of Prince Shōtoku a passage where Shintō, Confucianism, and Buddhism are called the "three systems," by their respective names, "Shin, Ju, Butsu," and as this Constitution was drawn up by the prince in the reign of the Empress Suiko (A. D. 593–628), we may suppose that the name Shintō was already known toward the close of the sixth century, although

its express mention, as far as I know, first occurs in the Nihongi of 720 A. D.

One fact which, although indispensable to the real understanding of this religion, is commonly overlooked, is this, that Shintō has a long history, for it has come down to us from the prehistoric ages of its native land, and during this long history it has experienced different fortunes and undergone different interpretations. Even at our own time there are at least nine distinct sects, which all go by the name Shintō, but are more or less different from one another, both theoretically and practically. The study of these present sects, their origin and characteristics, will be one of the interesting and instructive subjects of investigation. But for those who intend to study Shintō historically it will be quite convenient to divide the whole history of Shintō into three general periods—ancient, mediæval, and modern.

The *ancient period*, as I call it, commences with the beginning of the Japanese people, coming down to the close of the sixth century of the Christian era, when the influence of the foreign systems of religion and philosophy began to be strongly felt. This is the period during which Shintō remained almost in the state of original purity, and hence the period may be termed the "period of pure Shintō." The *mediæval period* of the history of Shintō begins with the seventh century and comes down to the latter half of the seventeenth century. It was during this period that Shintō lost its original purity and became alloyed with the philosophies and religions of China and India. Indeed, we know from history that during this period several attempts were made to amalgamate, in various proportions, these different elements from foreign as well as native sources, and the result was the appearance of diverse compounds thus made. "Ryōbu-Shintō" in the ninth century, "Yūitsu-Shintō" in the fifteenth century, and "Deguchi-Shintō" and "Suiga-Shintō" in the latter half of the seventeenth century, are some examples of these compounds. In fact, this period was not only the period during which Shintō lost its pristine purity, but also the period during which it was made to withdraw itself into the background, leaving the field to its foreign competitors. Its simple and *naïve* content could never be any match for the learned and orderly teachings of Buddhism and Confucianism. Hence this mediæval period may be called the "period of adulteration and decline of Shintō." The third and last period is the *modern period*, which covers the present century and the whole of the last. Toward the close of the seventeenth century, several circumstances which I can not enter upon here made a strong reaction against the foreign influences to set in, and the interest in the things primitive and purely Japanese was revived. In the next—

that is, the eighteenth—century, this reactionary tendency culminated in what is sometimes called the "Japanese renaissance of the eighteenth century." The scholars like Mabuchi, Motoōri, and Hirata then appeared in succession, whose far-reaching influence must be regarded at least as one of the main causes of the "restoration of 1868," when an end was put to the Shōgunate and the emperor was restored to his proper power and authority. Hence this modern period may be called the "period of the revival of pure Shintō."

It is true that revolution never goes backward. The revived Shintō of this modern period is not that simple and *naïve* Shintō of the ancient period. In the writings of the chief exponents of this revival we find that speculative or allegorizing spirit which is altogether foreign to the old Shintō; and, moreover, the reason why these men were able to become such exponents was because they were well versed in—not to name other things—the Buddhistic philosophy or the Chinese literature, or both. However, this modern period is the one in which the cry "Return to the things purely Japanese" is emphasized and felt. Especially since the "restoration of 1868" the interest in those things purely Japanese has steadily increased, although not without some temporary hindrances and disturbances.

This knowledge of the fact that Shintō has met these different fortunes and different interpretations, from time to time, is a necessary condition—I might almost say *the* necessary condition—for a proper understanding of its real nature, and one must keep this fact always before his eyes. Without doing so he is apt to make a big blunder. Sometimes, when one is expected to be talking about Shintō in its primitive state, he is really nothing more than describing its present condition. At other times, and that more often, when one is understood to be explaining the essential nature of Shintō, he is found, even to his own surprise, to be busying himself with the modified Shintō of the mediæval or modern period. The little carelessness of a writer results in the great mistake of many a reader, and such seems to be especially the case with numerous writings of those foreigners who with a positive air sketch in a few strokes "such and such is the real nature of Shintō," notwithstanding the fact that their conclusions are hasty ones based on scanty materials which are gathered from distant and doubtful sources.

As I am very anxious to avoid any such blunder, and yet as I can not, in this short paper, follow through the whole history of Shintō from its beginning to our own times, I will content myself with a brief sketch of the most important characteristics of this old religion—those characteristics which are common not only to the Shintō of all its different sects, but also to the Shintō of all

ages. The first characteristic I have in my mind is about the *objects* of Shintō worship. The second is the fact that Shintō is a religion of *purity*. The third and last characteristic I have to mention is about *merrymaking*, which plays so prominent a part in Shintō worship of all ages.

The objects which our forefathers worshiped or held in reverence were of different kinds. Among these objects ancestors were most important and are to be mentioned first. Then certain natural phenomena and objects are to be noticed, for certain natural powers, objects, and even animals were called deities and were held in reverence.

The fact that our forefathers worshiped these different kinds of objects is consistent with the meaning of the Japanese word for god—namely, *kami*. This word primarily means *high* or *above*, and is generally used in this primary sense. The upper half of the human body is called *kami*, in contrast to its lower half, which is called *shimo*. In our feudal times the governor of a province or district was called *kami*, being the head of the province or district. Even at the present time the local or central government is often called *o-kami* in the mouth of a country farmer. No doubt, when the term was applied to a god or gods, it was used in the same sense, meaning something standing high above human beings and possessing powers more than human. Thus a *kami* is simply an object of worship, and almost anything was regarded by our forefathers as an object of worship, in so far as it was mysterious and suggestive of good or evil influence. To them all their ancestors, who were wise in council or brave in war or even quick in temper, were suggestive of help or harm, and became the centers of myths and legends. To them the sun, which is the source of light and life; the moon, which does "wax and wane as if it were alive"; the fire, which is prone to anger and can consume everything in an instant; the thunder, which peals and roars, often striking men and beast to death; the mysterious principle of life, which propagates itself through and is represented by the organs of reproduction, and the like, are all wonderful and fear-inspiring. The cunning fox, which is peculiarly famous in Japan, was no doubt an object of fear and respect, while the mysterious serpent that "walks without feet" must have been a god also. Thus our forefathers could not help seeing an impressive object almost everywhere, and each one of these objects was called *kami* and was worshiped.

This fact is still more plainly seen in the absence in Shintō of any tendency toward idolatry—the tendency, I mean, to assimilate and embody the objects of worship in the visible form of man or beast. This tendency is absolutely lacking in Shintō. I freely admit that in the *Koziki*, the oldest book of Shintō,

there is a very strong tendency to identify most of the objects of Shintō worship with the ancestors of the imperial and other great families; but at the same time I firmly assert that among the Japanese of all ages there seems to have been no tendency to represent their objects of worship in the visible form of man or beast. Even the idea that an object of worship must be embodied or represented visibly is unknown to the Japanese mind. If any such idea or tendency is found at present, it is doubtless due to foreign influences, especially that of Buddhism. To the pure Japanese mind, an idol—a simulacrum of god—was unnecessary. Whether the absence of this tendency speaks favorably or unfavorably as to the place of Shintō in the development of religious consciousness in general, is not the point I am aiming at. My point is this: This absence of the tendency toward idolatry in Shintō indicates the absence therein of a more general tendency to assimilate the different kinds of the objects of worship into one type or one kind of objects. To the Japanese mind it was not incongruous or inconsistent to worship all sorts of objects. If certain animals were called *kami*, certain trees were also called *kami*, and both were worshiped. If certain ancestors were called *kami*, the sun and the moon were also called *kami*, and both were worshiped. Just as the meaning of the word *kami* is vague and comprehensive, so the objects of Shintō worship were diverse and heterogeneous.

As to the worship of "Heaven" in the sense of *one active and benevolent principle of Nature*, which has been said to be the essence of Shintō, there is no proof of its existence in our old historical records, the earliest of which was compiled in the beginning of the eighth century of the Christian era. Such an abstract and refined conception of Nature and its God no one can expect from any of the primitive peoples of the world. However, even in the "ancient period" of Shintō there was not wanting a certain tendency to make one deity—specially Amaterasu, the sun-goddess—supreme over all other deities. Later, when Chinese philosophy made its way to Japan and began to assert its influence, our forefathers probably for the first time came to have some conception of Heaven as the all-present and all-seeing, and as the punisher of the wicked and the rewarder of the good.

The physical purity or cleanliness of the Japanese people is unique and almost proverbial. The reason for this fact is found in the very nature of Shintō, which is a *religion of purity*, and which demands the utmost physical purity and cleanliness of its believers. Its rites and ceremonies for avoiding all sorts of uncleanness are numerous. For example, blood was considered to be unclean, and so anything stained with blood was also unclean. Thus the woman in her monthly courses or for some time before

and after a childbirth, was regarded as unclean. Uncleanness in these cases means liability to dangers. Thus the woman just before a childbirth was confined to a "parturition house," in order to keep her separate from the rest of the family to avoid the spread of danger by contagion. More than birth, death was feared because of its accompanying uncleanness. The dead body and anything which came in contact with it were regarded as unclean and dangerous. How much the uncleanness of death was feared is plain from a very singular custom among the early Japanese of abandoning the old house together with the dead body whenever a death occurred in it. This explains the reason why coffin-carriers, grave-diggers, as well as butchers, were classed among the outcasts and were called "not-men."

The reason why the idea of uncleanness was associated with the idea of dangerousness was, in my opinion, because uncleanness was thought to be the enemy of the gods, and the gods can not be where any uncleanness exists. The gods are clean and pure, and those who are not clean and pure can not but forfeit the protection of the gods. Those who are not protected by the gods can easily be attacked and injured by the evil and unclean spirits, and hence the idea of danger came to be associated with the idea of uncleanness. This is perhaps made plainer by some concrete case. When I was a young boy, the custom of eating beef began to spread. As blood was regarded as unclean, and also as Japan had been a strong agricultural country, there was a very deep-rooted disinclination to eat beef. In this, of course, one has also to recognize the influence of the vegetarian principle of Buddhism. But to anybody who had ever tasted beef, it was so delicious that he could hardly control his natural appetite by his religious scruple. My father was one of those who knew its taste, and so now and then we used to treat ourselves to beef. But where did we eat it? We did not eat it inside of the house. We cooked and ate it in the open air, and in cooking and in eating we did not use the ordinary utensils but used the special ones kept for the purpose. Why all these things? Because beef was unclean, and we did not like to spread this uncleanness into our house wherein the "gods-shelf" is kept, and into our ordinary utensils which might be used in making offerings to the gods. The day when we ate beef my father did not offer lights to the gods nor say evening prayers to them, as he did usually, for he knew he was unclean and could not approach the gods. Then my mother, who did not and could not eat beef till very recently, did these things; and I, who used to partake of the new dainty dish, often went to bed feeling as if I was unclean and subject to dangers.

As the gods hate uncleanness, temples, temple utensils, and all

other things which were connected with the gods were carefully kept clean—that is, away from any unclean things. For this purpose the *shimé-nawa*, or clean rice-straw rope, is used in many cases to mark off the sacred objects. If one travel in Japan even at present he will find many things thus marked off, especially in temple precincts. Here he may find an old tree with the *shimé-nawa* around its trunk. There he may see an old well marked off in the same manner. Thus, if he find anything with the *shimé-nawa*, he never does wrong to conclude that some kind of superstition, fear, or reverence is entertained by the people toward that object. Especially the unclean people are afraid of coming in contact with any object thus distinguished, because they believe they may thus incur some evil or punishment for defiling the sacred object.

In many cases, however, men can not avoid coming in contact with unclean things, and hence there are several means of purification in Shintō. Purification by washing with water is the commonest method. Sprinkling salt is another common method, and purification by fire is also common. Purification is performed at any time when it is necessary, either privately or publicly. The length of the time required for purification differs in different cases and degrees of uncleanness. Often one purifies himself, but sometimes he asks the help and intercession of the priest. There are two semiannual national acts of purification—one on the last day of the sixth month and the other on the last day of the twelfth month—when all the sins committed and impurities incurred by the whole nation during the past half year are purged away. These are called the "Great Purifications," and even now are performed at the great temples of Ise by the Emperor in deputy.

To the Shintōist the essential character of sin is impurity or uncleanness, and it has more of a physical than of a moral nature; for with the early Japanese, as with any primitive people, morality, if there was any, was more external than internal, more physical than spiritual. Many an act was regarded as unclean, not because it was morally and intrinsically wrong, but more because it caused physical uncleanness and made the parties concerned liable to the anger and curse of the gods. If anything is meritorious in Shintō, this strong emphasis of physical purity and cleanliness is one; and there can be no doubt that this Shintō teaching of physical cleanliness has had much influence upon the progress of moral cleanliness of the Japanese nation.

How the meaning of purity and cleanliness passed from external or physical to internal or spiritual, and how strong the practical influence of such a transference of the meaning was, can be seen from many facts. The great Shintō scholar Motoöri, who lived during the latter half of the last century and was one of the

leaders of the Japanese renaissance of the eighteenth century, boldly asserts: "Human beings, having been produced by the spirit of the two creative deities, are *naturally* endowed with the knowledge of what they ought to do and what they ought to refrain from. It is unnecessary for them to trouble their heads with systems of morality. If a system of morals were necessary, men would be inferior to animals, all of whom are endowed with the knowledge of what they ought to do, only in an inferior degree to men." Hence he concludes that, as the Japanese have and need no system of morals, they are superior to the Chinese, who have and need such a system. Some eight hundred years earlier than Motoöri there flourished another great exponent of Shintō, whose name was Michizané. Michizané was a patriot, statesman, scholar, and poet, and even at present he is one of the most extensively worshiped gods of Shintō. This hero has a short poem which is expressive of the old religious spirit of the Japanese nation, and which, being helped by the influence of his strong and noble personality, has had a very marked influence among our countrymen. The poem, if I may venture to translate it, is this:

"Only if our inner heart is
In harmony with the true way,
The gods will protect us,
Even though we do not pray."

The meaning of these lines is unmistakable. According to Michizané, religion can have no real existence apart from morality; but, on the contrary, if one live a pure and divine life, there is already in his life the reality of religion. If his heart is not in harmony with the heavenly way, and if he does not live his prayer in his life, mere verbal prayer is of no account, because the gods care more for the real purity of our heart than for the empty prayer of our mouth.

The other important characteristic of Shintō is that this system is a *religion of naïve optimism*. Our early forefathers seem to have been remarkably happy and cheerful in their temperament. "To live happy with gods and men" seems to have been the long and short of their religion as well as of their life. If any misfortune happened, they ascribed it to the anger and curse of the gods, and by offerings and festivals they tried to appease the gods and to restore their favor. If everything went well, and especially when the annual produce of the soil was plentiful, again they ascribed this to the favor and mercies of the gods, and by offerings and festivals they praised the gods and rejoiced themselves. Thus there are numerous festivals of the Shintō gods all over the country. These festivals may be classified as public and private, and also as regular and occasional. The

greatest annual festivals naturally come in autumn—that is, our harvest time. It is in these festivals that the *saké*, the "Japanese rice beer," that "cheereth gods and men," plays such an important part that no festival can be complete without it. The *kagura* is also indispensable in these festivals. It is a theatrical performance, where music and dancing come together to entertain the gods as well as men. Many other religious dances of both comical and dignified natures are also performed. The wrestling too was at first a part of a religious festival. Of course, during these festivals many and generous offerings are made to the gods to show gratitude, while at the same time alms and gifts are very freely given to the poor. Thus it is plain that in the mind of the early Japanese the gods were not very different from them nor very far from them. The gods and their worshipers lived together, enjoying each other's company. The festivals were as much for gods as for men. The offerings were not for the poor, as in Christianity, but they were real and actual offerings to the gods themselves. The music was not merely to praise the gods, but was mainly for the purpose of pleasing them.

Thus, Shintō is a religion of merrymaking, a religion of enjoying this life to its utmost extent. I say "this life," but this does by no means imply that Shintō denies the future existence of the soul. Surely it implies the belief in such an existence. On this point a great mistake was made by some. No error can be more superficial than this, but, strange to say, even some missionaries fell into it! Plainly enough Shintō does not expressly teach the eternal existence of the soul or the doctrine of eternal punishment. It does not know the immortality of the soul, as we have it in Christianity. Such a dogma is foreign to Shintō, as the Buddhist doctrine of transmigration is foreign to it. But the fact that Shintō implies and even teaches some kind of future existence is indisputable from the very fact of ancestor worship, which necessarily implies the belief in the existence of the now deceased ancestors somewhere.

This belief, however, must have been very vague and indefinite. Our early forefathers did not believe their religion in order to be saved from tortures in the next life. To them religion was something of more immediate concern. They did not care much for the next world. All that they cared was to enjoy this present life as best they might. To this end they did what they could, and were happy and satisfied. But they were mortals and could not help dying. No doubt death was not pleasant to them, and they did not like it. Yet to them death did not have any associations of a hideous nature, such as going to hell, eternal torments, and the like. They thought probably that after death one will continue to live somewhere else than here on this earth.

Even there was a custom of the retainers following their deceased master to the grave, being buried alive. This indicates the *naïveté* of their thought, and at the same time the recognition of some sort of future existence. They also thought that the deceased have some interest in the affairs of their friends and relatives who are still living on this earth. This belief is still quite common among the Japanese, even among the educated classes; and who can say that it has nothing rational and helpful in it?

The fact that the early Japanese were remarkably optimistic in their temperaments and dispositions is to be properly emphasized. Here, in conclusion, I will cite only two facts which confirm this statement. In the first place, it is true that Buddhism pessimized Japan, but at the same time it is also true that Japan optimized Buddhism. This is, of course, too big a subject here to enter in any detail. However, if any one carefully compares the Japanese Buddhism with Buddhism of any other country, he will surely find out that our Buddhism is more optimistic than that of anywhere else. The cause of this, it seems to me, lies in the natural tendency of the Japanese mind to see the bright side of things. The hare in the moon, instead of pounding drugs as a punishment, as a Hindu legend has it, is described in a Japanese legend as making *mochi* or rice pastry—the national cake of Japan—which represents the joy and happiness of the new year. The other fact is this: Some time ago an American lady who was in Japan for many years told me the following incident, which is almost an everyday occurrence in Japan. While the lady was in that country, one of her Japanese friends, who had recently married, died. So the lady made a call to condole the family deprived of its head, when she was surprised by the young widow, who thanked the American lady, expressing her sentiments by words like these: "I am sure that my husband must be glad to have your company here to-day, and be thankful for your kindness." This was quite a new experience to the American lady, who never expected such cheerful words from a bereaved young widow, and who never had happened to see the belief in the future life from such a point of view.

Thus, to the Japanese, especially to their early ancestors, the utmost enjoyment of this earthly life—that is, to be happy with gods and men—was the final object of their existence. To them religion was nothing but the very means of accomplishing this end. This is evident from the fact that in our olden times all festivals were religious, there being no distinction between religious and secular. By eating, drinking, singing, and dancing, which form the main elements of these festivals, they wanted to be happy with gods and with men. Therefore I say that Shintō may be defined, from this aspect, as a *religion of merrymaking*.

THE ANCIENT OUTLET OF LAKE MICHIGAN.

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THE reports of several of our State Geological Surveys contain references to former outlets of the Great Lakes, when their waters were for some reason turned from their present lines of discharge. A brief mention of the ancient overflow of Lake Michigan across the flat divide at Chicago and down by the Desplaines and Illinois Rivers to the Mississippi appears as long ago as 1868 in the account of the geology of Cook County, Illinois, by Bannister, in the third volume of the Geological Survey of that State; and of this more below.

A more explicit description of the ancient Maumee-Wabash outlet of Lake Erie was given more than twenty years ago by G. K. Gilbert in the first volume of the Geological Survey of Ohio. The region is very flat, with a faint divide separating the eastern and western slopes; across this divide the old channel is "not less than a mile and a half broad, and has an average depth of twenty feet, with sides and bottom of drift. For twenty-five miles this character continues, and there is no notable fall." To the northeast, the channel opens out on the even floor of an ancient lake, whose shore lines diverge to the outlet. In the southwest the channel touches bed rock at Huntington, and then descends more rapidly. Most of the flat passage from the lake outlet to the sill of rocks is now "occupied by a marsh, over which meanders the Little River, an insignificant stream, whose only claim to the title of river seems to lie in the magnitude of the deserted channel of which it is the sole occupant. At Huntington the Wabash emerges from a narrow cleft of its own carving, and takes possession of the broad trough, to which it was once but a humble tributary." Mr. Gilbert's further account of the peculiar river courses of that district is extremely interesting, and illustrates to perfection how much meaning can be given by intelligent study to a country as flat and apparently monotonous as northwestern Ohio. It is noticeable that the explanation which Mr. Gilbert then suggested for the reversal of the present overflow of Lake Erie was an uplift of the land to the northeast; but Prof. Newberry, director of the State Survey, calls attention in a footnote to the possibility that the overflow resulted from an ice barrier in the valley of the St. Lawrence; and to this conclusion nothing has lent stronger support than Mr. Gilbert's subsequent observations of marked lacustrine shore lines in New York, from which we know that the land was depressed and not raised in the northeast at the time of this and other similar overflows.

The broad channel now followed by the Minnesota River is analogous to that across the Maumee-Wabash divide, although the lake from which the river flowed to cut the channel has shrunk away so far as to withdraw its waters beyond our northern boundary. The former occupation of the Minnesota channel by a large river was first pointed out by General G. K. Warren, in the Annual Report of the Chief of Engineers, 1868, page 307; and a fuller account of it was published in the American Journal of Science for December, 1878. Warren looked to a northward elevation of the land as a reason for the former southward direction of drainage, as Gilbert had done in Ohio; and this view generally obtained until the region was carefully studied out by Warren Upham, whose reports are found in the annual volumes of the Minnesota Geological Survey, and by whom a special account of the valley is given in the Proceedings of the American Association for 1883. Here the name of river Warren is proposed for the ancient stream by which this great trough was excavated: in earlier papers Upham had given the name of Agassiz to the lake from which the river issued. Further account of the ancient lake and river is found in the first two volumes of the final report on the Geology of Minnesota, now in progress.

The same observer has described a southwest overflow from Lake Superior, when the greater part of its basin was presumably occupied by retreating ice, and its waters rose about five hundred feet above their present level. The overflow took place across the pass between the valleys of the Bois Brulé and the St. Croix Rivers in northwestern Wisconsin; the channel across the pass being about a thousand feet wide and nearly a hundred feet deep, although its depth is now somewhat decreased by a marshy filling from which the headwaters of the Bois Brulé run back to the present lake (Geological and Natural History Survey of Minnesota, ii, 1888, p. 642). The lower course of the St. Croix follows a "great valley," whose fuller history is deferred to later volumes of the Minnesota Survey; its lakelike expansion above its confluence with the Mississippi is said to be due to alluvial obstruction by tributaries (ibid., pp. 377, 643). These studies by Upham in the Northwest were only continuations of the work that he had begun in New Hampshire several years before, where he recognized the shore lines of a small glacial lake in the southern part of the north-sloping Contoocook Valley, with an overflow to the southeast at Greenfield, N. H. (Geological Survey of New Hampshire, iii, 1878, pp. 116–119). A few years ago, in company with Mr. C. L. Whittle, I traced out a number of deltas and shore lines on the slopes of this picturesque valley, but have not since then been able to complete the attractive study of mapping and restoring the old lake.

Upham's observations on the shore lines of Lake Agassiz have fully demonstrated that in northern Minnesota and Dakota, and in Manitoba farther north, the land was depressed, not elevated, at the time of the overflow of river Warren from Lake Agassiz; and hence, there as in the St. Lawrence Valley, the cause of overflow must be looked for in the retreating front of the Pleistocene ice sheet. In the Bulletin of the Geological Society of America (vol. ii, 1891, pp. 243–276) Upham has described a number of glacial lakes associated with large river channels, north of our boundary in Canada. The channels are now deserted by the great streams that carved them, and are occupied only by smaller streams, which are frequently "laked" by the alluvial deposits brought in by lateral tributaries, as will be referred to again further on.

In 1885 Gilbert traced out the shore lines of the expanded waters of Lake Ontario, afterward named Lake Iroquois by Spencer, and showed that they converged to the southeast, and at Rome, N. Y., an outlet was found through what is now called the valley of the Mohawk. Only a brief mention of the attractive problem offered by this locality has yet been published. Spencer has called attention to the probable former discharge of Lake Huron and Georgian Bay across the province of Ontario by way of the river Trent (Proceedings of American Association, xxxvii, 1888, p. 198); and Gilbert has suggested that at an earlier stage there was another outlet farther north, by way of Lake Nipissing and the Ottawa River—the account of this being found in his excellent History of the Niagara River, published by the Commissioners of the State Reservation at Niagara, in their sixth annual report. The reading of this history will greatly increase the pleasure of an intelligent visit to the great cataract. It was of the outlet by way of the Ottawa River that Wright gave an account in the New York Nation for September 22, 1892.

The abandoned channel of overflow of the ancient Lake Bonneville at Red Rock Pass in northern Utah, and the "old river bed" leading from Sevier Desert to Great Salt Lake, well known from Gilbert's monograph, are analogous to the old channels here considered, although the overflows there were not produced by glacial barriers.

All these abandoned channels have certain features in common. At their upper end, where they trench across a divide of greater or less distinctness, they open out upon lacustrine plains of greater or less extent and distinctness, whose converging shore lines may be traced to the point of discharge. The breadth of the abandoned channel is relatively constant throughout a great part of its length; from which we may infer that the volume of water received from the lake at its head was large in comparison with that received from the tributaries lower down in its course. None

of the deserted channels are cut to a great depth; but, whatever their depth, they are inclosed by banks or bluffs that are still distinct and comparatively steep; thus showing that relatively short periods of time elapsed both during and since their occupation by large rivers. The rock-cutting done by Niagara in post-glacial time seems to be a much greater piece of work than that accomplished by any of the temporary lake outlets during the closing phases of the Glacial period; but none of them, as far as I have read, had an opportunity for active work equal to that of Niagara.* They are nearly all comparatively shallow; but an exception to this rule has been pointed out to me by Mr. Gilbert, to which a paragraph may be devoted.

Emmons, the geologist of the second district of New York, long ago described what he took to be fissures in the Potsdam sandstone of northern New York, but which to modern interpretation appear to be gorges or chasms cut by rivers, presumably constrained into that position by drift or ice obstruction. The Ausable chasm is a well-known instance of these "fissures," but one of the examples described by Emmons has no river running through it. It lies close to the Canadian boundary in Clinton County, sixteen miles west of Lake Champlain, and is thus described in Emmons's report (Geology of the Second District, New York, 1842, pp. 309, 310): "The fissure or gulf, as it is called, is three hundred feet deep and about sixteen rods wide. Its walls of sandstone or conglomerate are perpendicular at the deepest part. The small lake at the bottom is said to be one hundred and fifty feet deep. The direction of this fracture is north, seventy degrees west, and the rock dips at a small angle from each side of it. . . . At Keeseville and Cadysville large rivers, the Ausable at the former and Saranac at the latter, still occupy these gorges as their channels, and have sufficient force and power to sweep out, especially in the time of high water, all rocks of an ordinary size. At this place there is merely a small rill discharging itself from a small lake of dead water, insufficient in itself to accomplish any perceptible change. To account for the present condition of this rock, we have therefore to go back to a period when some current swept through this gorge with great force and power; for by no other means could the materials which once filled the space between the present walls of the gulf be removed."

Returning to the general features of the abandoned channels,

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* Russell's Geological Reconnaissance in Central Washington gives an account of a temporary displacement of the Columbia River when its valley was obstructed by ice and its waters ran through the Grand Coulée: a basin was then excavated beneath a cataract in the course of the river, and the basin now holds a lake, although the river and the cataract have disappeared (Bulletin 108, United States Geological Survey, pp. 91, 92).

it is next to be noted that the small lateral streams which now enter the old river course find it much too large for their volume. This is especially true near the divide across which the old channel was cut. It is only at some distance down the channel that enough water has entered through lateral streams to form a considerable river; yet all along the channel maintains about the same width. Evidently, therefore, it was not cut out by the existing drainage. In consequence of the small volume of the longitudinal streams now occupying old channels, they are frequently more or less obstructed by the alluvial fans built at the entrance of lateral tributaries; thus swamps or long, narrow, lakelike expansions of the rivers are produced up stream from the fans. This was first noticed by Warren, and since then the list of examples has been greatly increased by Upham and others. In the last of Upham's papers referred to above, he describes a number of lakes of this kind on the Qu'appelle and Pembina Rivers and elsewhere. Long Lake in Assiniboia is about fifty miles in length, but only one or two miles wide. Lac qui Parle and Lake Traverse, in the old channel at the head of the Minnesota River, are of this kind. The sluggishness of the Minnesota and of the Illinois Rivers just above their junctions with the Mississippi has been attributed to the same cause, and this would indicate that at the time when the channels of the Minnesota and the Illinois were occupied by the large rivers which once flowed through them, these held the place of main streams, while the Mississippi came into them with smaller volume as a tributary.

There is on this account a curious contrast to be noted between the excavation of the late glacial channels that were cut out during the closing stages of the Glacial period by the overflow from glacial lakes, and the clogging of the preglacial valleys that were commonly filled with sands and gravels by streams that came directly from the retreating ice front without delay and filtering in lakes, as in southeastern Ohio. Both of these kinds of valleys mark the courses of "constrained" drainage near the end of the Glacial period. At the ice front the water supply in both cases was doubtless surcharged with detritus; but the waters that had to accumulate in lakes marginal to the ice front before flowing away as rivers must have been nicely filtered, so that they issued clear and blue from the lake outlets; while the others had to carry their detritus down stream for many miles, and must have been of gray and turbid color for long distances. The plentiful clear waters of the streams of the first class ran down the valleys that led from the lowest pass in the lake rims and cut down their channels to a moderate grade, oftentimes so moderate that the present river occupants of the valley are unable to keep them clear of the alluvium that is brought in by tributaries;

hence they are frequently characterized by swamps or linear lakes, especially near their heads. On the other hand, the streams of the second class, surcharged with detritus from the ice, frequently demanded a steeper grade than they found, and therefore deposited much of their load, filling up their valleys with broad flood plains of sand and gravel, such as are now growing in front of the Greenland and Malaspina glaciers; and sometimes they may have transformed side streams into lakes, such as now characterize the side streams of the Red River of Louisiana.

The record of the latter feature is truly a rarity in the past, but it has been deciphered by Andrews as perceptible in some of the lateral tributaries of the gravel-filled valleys of Ohio. The following is Andrews's account. After describing the terraces of sand and gravel derived from the glacial drift and occurring along those streams whose sources lie in the "area of the general drift," he says: "There is in the second district [southeastern Ohio] another and very distinct system of terraces, found on streams emptying into the larger streams bordered by true drift terraces. They may be called backwater terraces. When in the Ohio, Muskingum, Hocking, etc., rivers, the water in the drift era stood eighty or ninety feet higher than at present, the backwater would set back up all the tributaries. In this still water the sand and sediment brought down these tributaries were deposited; or, in other words, the still-water areas were silted up, as mill ponds often are. When afterward the main streams fell to their present level these affluents cut through the backwater beds and carried away much of the soft materials, but left in many places fringing terraces which tell very plainly how they were formed. In these backwater terraces we find no true drift sand or gravel. The beds are entirely of home origin. Such terraces I have seen in the Little Scioto River, above its junction with the Ohio at Scioto-ville, on Duck Creek, and on the Little Muskingum River in Washington County, and on Sunday Creek in Athens County. I have no doubt they are to be found on a large number of streams." (Geology of Ohio, ii, 1874, p. 444.) This record shows a delicacy of observation and a skill in physical interpretation that have impressed me as exceptional and admirable.

Taking up again the comparison of the two classes of constrained streams, it is seen that the channels of the first class were cut down to so gentle a grade by the filtered glacial streams that they are now not infrequently found to be filling up, and lakes are forming in them; but the valleys of the second class were filled so high by the gravels deposited from the surcharged glacial streams that they are now being terraced, and the lakes that were formed on their lateral tributaries are now discharged

by the cleaning out of the clogged valleys. A pretty contrast for our geographical lessons!

It is noticeable that the abandoned channels of the glacial lakes are now generally utilized as natural paths of communication. The Indians easily passed from the head of the Minnesota to the Red River of the North; and indeed at times of high water they paddled their canoes over the flat divide. The Chicago outlet of Lake Michigan was naturally chosen for the path of the Illinois and Michigan Canal, and now two railroads follow the same well-graded course. More important still is the broad channel into which the Mohawk flows from the Adirondacks, and which we therefore call the Mohawk Valley. This well-opened passage determined the location of the Erie Canal; and that, taken with the drowning of the Hudson River, by which navigable tidewater is carried up to Albany, has undoubtedly been the determining cause in the development of New York city as our greatest seaport.

As a good number of these abandoned channels have been described, and as it is very probable that others will be found, it seems to me worth while to recognize them as constituting a special group of river-made forms of brief and peculiar history, deserving recognition and representation in our study of physiography. In this connection a particular interest attaches to the former outlet of Lake Michigan, because it is the only one of the old outlets that is now mapped with any approach to accuracy. Twelve sheets prepared by the United States Geological Survey —namely, the Chicago, Riverside, Calumet, Desplaines, Joliet, Wilmington, Morris, Ottawa, Marseilles, Lasalle, Hennepin, and Lacon sheets—already represent a length of over a hundred miles of the former lake outlet, and give an effective illustration of its peculiar features.

Before speaking of the old channel, I must turn from that theme to give the maps a fuller introduction, for they seem as yet to be very little known to our teachers and scholars. They are constructed to serve as the topographical basis for the geological map which our national survey is charged to prepare. No suitable map existing, Major Powell, director of the survey, organized a topographical corps in 1882, under the charge of Mr. Henry Gannett, to whom the mapping of the country was intrusted. The progress of the work has manifestly been embarrassed by the expense of the survey over so vast a country, by the need of comparatively rapid progress, and by the difficulty of securing experienced topographers; but all considerations of distribution, scale, cost, and time have been duly discussed, and as a result we have already several hundred map sheets of areas distributed over many States, on which the topographic features of

our land are represented to us as they never have been before. The scale employed varies from one to four miles to an inch on the maps thus far issued, but in future only the larger scale of a mile to an inch will be used. Relief is indicated by brown contour lines at intervals varying from five to fifty or more feet, according to the scale of the map and the character of the surface. Water is printed in blue; names, roads, boundaries, etc., in black. The accuracy of the work is not so great as many geographers and geologists would like to see. The expense of more accurate work would perhaps prevent its execution; but it may be justly said that a great increase of knowledge is made by the publication of these maps. Some of the sheets are better than others, and some of the poorer ones have been severely criticised by those who know the ground; but, as far as I have been able to observe, the character of the work is rising, and the interest in it is increasing. A sympathetic popular support and an intelligent criticism of this great undertaking will go far toward securing its improvement and extension. The study of geography will be greatly advanced when these maps are properly distributed to schools, as they soon should be, so that every high school at least would have not only its own district represented, but would possess also a collection of typical maps of other districts.* At the same time the demand for more and better maps will be increased. In my own teaching, I find these maps simply invaluable. It is not only the younger students who learn lessons from them. Many a problem is effectively introduced and illustrated by the maps that would otherwise remain out of reach to teachers as well as scholars. The case which I am about to describe illustrates this point very clearly.

On noticing, a year or more ago, that the topographic sheets thus far issued for Illinois included a good part of the old Michigan outlet, I resolved to have a look over the ground at the first opportunity. A visit to the World's Fair was therefore arranged to include a trip down the Illinois valley, maps in hand, and in the good company of several friends from the Chicago University. The assistance given by the maps in gaining an appreciation of the form of the country raised the high estimate that I had previously formed of their educational value. They are simply indispensable in geographical study.

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* It may be noted that the conference on geography held in Chicago in the winter of 1892–'93—one of several conferences held under the auspices of the National Educational Association—appointed a subcommittee to prepare a list of these and other governmental maps of use in teaching. This list has been published, with explanatory notes, under the title of Governmental Maps for Use in Schools, by Messrs. Henry Holt & Co., New York. Many of the maps can be obtained free of cost from the governmental bureaus, and others can be had for a merely nominal cost.

Lake Michigan is inclosed at Chicago by the contour line of five hundred and eighty-five feet above sea level; and the lacustrine plain on which Chicago is built lies mostly under the contour of six hundred and ten, the western suburbs rising to six hundred and thirty feet. In the southern part of the city, near the World's Fair grounds, several faint sandy lake ridges may be traced, rising three or four feet above the dark soil of the plain. The Desplaines River comes from the north on the western part of this plain, ten miles from the lake; its narrow channel, with comparatively steep banks to the water's edge, being sunk ten or twenty feet below the plain. Opposite Summit Station, on the Chicago and Alton Railroad, the river enters a broad, swampy trough, which it follows to the southwest. It is this trough that was briefly described as the lake outlet by Bannister twenty-six years ago; and from his rather casual mention of it I infer that its meaning was then generally appreciated by those who were familiar with the ground. Since then it has been frequently mentioned in a general way in geological literature. The trough is about a mile wide and lies just below the contour of five hundred and ninety feet. Its banks become better defined as it enters the rising ground farther west. From the entrance of the Desplaines eastward to the lake there is no perceptible divide. The canal by which the South Branch of the Chicago River is connected with the Desplaines joins the channel in the western part of the city; and it is by deepening the river channel farther down stream (southwest) that a sufficient volume of lake water is to be diverted through Chicago, thus returning, in a measure, to glacial conditions of drainage, and purifying what is now a very turbid stream.

In addition to this chief passage across the flat divide, there is another one, also mentioned by Bannister, about twelve miles farther south at the village of Blue Island, on the southern end of Washington Heights (six hundred and fifty feet). Here is a long, shallow, swampy trough, again at a level of five hundred and ninety feet, running west from the lacustrine plain through the rising land, and joining the Desplaines at Sag Station, Chicago and Alton Railroad, nine miles below Summit. The Calumet River runs toward the trough from the southeast, but turns abruptly eastward near Blue Island and flows to Lake Michigan. The western end of this southern trough is drained into the Desplaines by a little stream called the Feeder. The swampy part of the trough, between the Calumet and the Feeder, is probably inclosed by faint alluvial fans, swept down by brooks from the higher ground on the south; indeed, it is quite possible that the abrupt turn in the course of the Calumet at Blue Island results from the obstruction of a former westward course in this manner.

The plain west of Lake Michigan, for a distance of twelve or

fifteen miles, appears to have been under the lake waters during the greater time of the westward overflow. Its level surface, its fine, dark soil, and the occasional sandy ridges that traverse it have already been mentioned. Its western boundary, at the point where the Rock Island Railroad gradually ascends to higher ground, is rather distinctly defined by a low but definite bank, apparently an old shore line of the lake, the base being near the contour of six hundred and twenty feet.

Farther west there is a belt of higher ground, whose contours reach seven hundred or seven hundred and fifty feet. On the topographic maps this belt appears to be a plateau-like swell, well dissected by streams; but on the ground it has the appearance of a faintly marked moraine, and it is so represented on the soil map of Illinois, prepared by Mr. F. Leverett and exhibited in the Illinois State Building in the World's Fair. Its morainic form is indicated by numerous faint mounds and small hollows, and the railroad cuts show it to be composed largely of drift. The spurs and valleys, apparently of simple drainage development as indicated on the map, do not justly represent the expression of the surface at this point. A more appreciative drawing of the contour lines is required to express this faint morainic topography; but I do not think it should escape representation on a scale of 1 : 62,500. It would be interesting to compare a careful contouring of a small portion of this belt with its generalized portrayal on the survey sheets.

The old channel, now occupied by the Desplaines, crosses this belt of higher ground in a well-marked trough. The breadth of the flat bottom of the trough is almost constant at a measure of a mile; its depth below the immediately adjacent upland is about seventy-five feet. This is partly cut in horizontal Niagara limestone, and the descent into the flat-bottomed trough is accomplished on steep sloping bluffs, somewhat dissected by narrow, short, and steep-sided ravines. This may be called the Lemont channel, from the village of that name at its middle, where quarrying is now going on in the limestone in order to increase the westward discharge from Lake Michigan, as stated above.

The morainic belt has a width of fifteen or twenty miles on the Desplaines and Joliet sheets. Joliet lies near its western base. Farther west there is a second belt of higher country, also represented as a morainic belt on Leverett's map, of which further mention will be made below. Between the two belts there is a strip of lower country, about twenty-five miles wide, whose elevation at and below the junction of the Desplaines and Kankakee Rivers varies from six hundred to five hundred and fifty or less. This I shall call the Morris basin, from a town of that name near its middle. On entering the basin, the old channel is less dis-

tinctly defined than before, chiefly because of the smaller depth to which it could be cut in the lower ground. The bluffs are only about fifty feet high at Joliet, while at Morris, eight miles below the entrance of the Kankakee, they are hardly perceptible. Through this district the floor of the old channel is generally rocky, and in the floor the Desplaines River—or the Illinois, as it is called below the entrance of the Kankakee—has cut a narrow and shallow trench. Occasionally heavy gravel beds were seen, but their origin could not be determined in our rapid excursion.

A peculiar feature of the northeastern part of this district is the subdivision of the old channel into several courses, as if a number of almost equally good lines of escape had been originally offered to the lake overflow, along all of which the waters ran for a time, but into one of which they were gradually collected, that one being the channel now followed by the Desplaines past Joliet. Two of these temporary branching channels are represented on the Joliet sheet, a short distance above that city, in the form of swampy passages connecting the Desplaines with the Dupage River. A third is seen southwest of Joliet, and is now utilized by the Illinois and Michigan Canal.

The second belt of higher ground again reaches a level of seven hundred and fifty feet north and south of the town of Marseilles, after which it may be named; and through this belt the old channel again appears as a depressed linear plain, now about a mile and a half wide at an altitude near four hundred and ninety feet. It is inclosed by steep bluffs, a hundred or more feet in height. Back from the bluffs, narrow and steep-sided ravines dissect the rolling upland for a distance of from two to four miles. There are flat alluvial fans in front of some of these ravines, and it may be for this reason that several small lateral streams in the neighborhood of Marseilles enter the river by direct courses instead of first running a distance down the valley, as is so often the habit of side streams while traversing the flood plain of their master. The contour lines of the maps do not indicate the occurrence of any fans, the lines being concave toward the mouth of the streams; but I think some of them should be slightly convex in that direction. It is possible that small matters of this kind may have escaped the attention of the topographers, although the scale of the maps is large enough to show them clearly if they really exist. As in the Morris basin, the present river about Marseilles is sunk in a narrow trench, twenty or thirty feet below the broad plain of the old channel bottom.

West of the Marseilles morainic belt—the second belt of higher ground—there is a broad stretch of even country at a height of about six hundred and fifty feet. The city of Ottawa is located in the old channel where it traverses this even upland; the in-

closing bluffs here vary from seventy-five to a hundred feet in height, being frequently cut back by ravines, as already described. The level of the Illinois River at this point is a little under four hundred and fifty feet. The floor of the old channel stands at four hundred and seventy feet. Its descent from Summit Station is therefore one hundred and twenty feet in about seventy miles; but it must be remembered that part of this slope may be due to post-glacial elevation of the land to the northward.

The entrance of the Fox River from the north at Ottawa was one of the special features that I wished to see. It runs near the western base of the Marseilles morainic belt, and its trench below the general upland is as deep as the old channel; but it is narrow and steep-sided, like the many side ravines of the old-channel bluffs, although in volume the Fox is at least half as great as the Illinois. It has a flood plain of slight width where its banks are of fire clay, as at Dayton, three miles from Ottawa; but farther up and down stream, where it is inclosed by sandstones, the rocks rise directly from the water's edge, and steep bluffs rise above the rocks to the upland. The descent of the river bed is relatively rapid, amounting to about sixty feet in the first ten miles above its mouth.

The other rivers that enter the old channel present the same peculiarity as the Fox, but as they come in over lower ground their valleys are less deep, and therefore less noticeable. The Desplaines has already been described as flowing in a narrow trench in the plain west of Chicago, until it abruptly enters the swampy bed of the old channel. The Kankakee has a similar narrow valley when it joins the Desplaines, from the southeast, in the Morris basin, the two rivers forming the Illinois. Next is the Fox, and below this is the Vermilion, with a steep-sided, narrow valley like those of its fellows. The contrast between the narrow valleys of the side streams and the broad channel followed by the Illinois is strongly marked.

This is all plain enough on the ground; it is distinctly shown on the maps; but it should also be represented by photographs. If any readers of this article happen to have views illustrative of the district here described, I beg that they will communicate with me. There should, indeed, be a photographic exchange established by a union of our professional and amateur photographers, in which good views might be selected under certain conditions for purchase or exchange. At present it is a very difficult matter to find views of the simpler landscapes of our country, however well represented the greater mountains may be.

When all these features are considered together, there is good warrant in the old belief of the southwestward overflow of Lake Michigan. The considerable breadth of the old channel, in which

the Illinois is cutting a narrow trench, must be due to the great volume of the old lake outlet which once filled the channel from bluff to bluff, just as the present tributary rivers fill their valleys. The old outlet river fitted its broad valley as well as the existing rivers fit their narrow valleys. It must have been large compared with its tributaries, because the breadth of its channel increases so slowly in a distance of nearly a hundred miles. Like the Niagara below Buffalo and the St. Lawrence among the Thousand Isles, the old outlet near Joliet split up into a more or less complicated network of channels, and its discharge seems to have continued just about long enough for the selection of one of these as the survivor. But it is manifest that the old outlet, like all its fellows from other expanded lakes of the close of the Glacial period, did not exist long enough to broaden its channel by lateral meanderings. The special phases of climatic periods by which these constrained river courses were determined were too short-lived to allow the development of meandering rivers—far too brief to measure so long a part of a river's history. The old outlet of Michigan endured long enough to clear off the drift from its path, and to make a beginning of cutting its channel down into the underlying rock; but it does not seem to have cut the rock down as deep as it might have done if more time had been allowed, for even the smaller rivers of to-day have trenched the floor of the old channel since the outflow of the lake has been turned over another path. To be sure, something of the ability to do this may be ascribed to the change in the attitude of the land, a presumable elevation to the north since the ice went away; but we have no definite measures of the amount of this elevation in the district here considered.

The good fortune of having maps of this interesting district should bring it clearly before many students who may not see it on the ground. It appears to have so many features common to the other examples of its class that it may well be taken as their type. As other similar channels are mapped, it will be interesting to see how far their essential features are merely repetitions of those so clearly shown on the maps of the old outlet of Lake Michigan.

With reference to Croll's and Ball's theories of ice ages and genial ages, Mr. Edward P. Culverwell has shown, on the basis of calculations of the daily distribution of solar heat on different latitudes at the present time and in the supposed glacial and genial ages, that the winter temperature of Great Britain in the glacial age, as dependent on sun heat, would be no lower than that from Yorkshire to the Shetlands, and similarly that, from 40° to 80° of north latitude, the shift of the winter isothermals would be only about 4° of latitude, a result wholly inadequate to produce an ice age. The shift of isothermals in the genial age was found to be still smaller.

THE CHEMISTRY OF SLEEP.

By HENRY WURTZ, Ph. D.

WE do not comprehend the mystery of wakeful consciousness; and therefore that of temporary unconsciousness, including sleep of all kinds, is equally beyond our understanding. To say that sleep is a suspension of our control over our thoughts and our motor nerves and voluntary muscles is a mere substitution of other classes of mysteries equally inscrutable.

The same should be frankly admitted as to all our so-called explanations of natural phenomena, which consist mainly of generalizations, expressing in few words the laws that rule and connect, so far as we can discover, the infinity of cosmical facts and transformations. Such generalizations—whose surpassing importance and value are nevertheless undeniable—imply, as essential preliminaries, the laborious classification of the facts in any field of investigation that we have in hand.

But in the field of which we are now to attempt a brief and necessarily superficial survey it must be conceded that such classification is as yet highly imperfect. The forms and modifications of existence varying in cause or origin, nature, and degree which may be called by the general name of sleep have not yet been subjected to the exact and critical experimental research needed for scientific classification. Little can now be done except to point out wherein our knowledge is defective, and to indicate some more or less tentative arrangement of the facts under different heads as a provisional guide to the study of this condition of existence, in which mos persons expend one third of their terms of life. Such heads may be as follows:

An attempt at a *definition* of normal healthy slumber, which only is entitled to be called—

"Tired Nature's sweet restorer, balmy sleep."

Such a definition must be sufficiently well founded on the conditions presented in natural sleep to admit of drawing lines of parallelism with and of divergence from other species of lethargy or unconsciousness, or modified consciousness, that arise from abnormal or morbid conditions, mental and nervous disorders, drugs, anæsthetics, cold, heat, exhaustion, partial asphyxiation by drowning or otherwise, etc.

A statement of our present narrow range of facts and observations relative to the chemical, physical, and physiological changes of the organs of the body, and of their functions, during normal sleep.

A consideration of the mental, moral, and emotional phenom-

ena presented in natural and in artificial sleep, including its morbid forms, with those forms in which the mind sleeps with the body awake, and those in which the body may sleep with the mind more or less awake.

Anæsthesia in general, inclusive of its widely differing successive stages, as that of exaltation of some mental faculties, with or without full consciousness, or one of the waking dream conditions (see further on)—that of extinction of full consciousness with the muscular system still awake—and, finally, that of complete lethargy of the mind and body with extinction of all sensation.

An attempt, which must needs yet be quite crude, to generalize something useful from the sparse and scattered array of facts thus found to be available.

As to a definition of natural sleep, it may be interesting to go back a century and examine the views then held. Having at hand the second edition of the Encyclopædia Britannica, published from 1778 to 1783, the writer finds therein an article on Sleep, in the tenth volume, which article is brief, being but supplementary to that on Dreams, in the fourth volume. To this latter subject we shall return further on. Under Dreams, the following meager definition of sleep is given: "Sleep is a state in which all communication is cut off between our sentient principle and this visible world." By this, taken literally, a blind man would be asleep. But, of course, the word visible was intended to imply the whole world of the senses. Still, allowing such latitude, the definition is both inaccurate and inadequate. As to the asserted complete cutting off of external impressions from the senses in true sleep: were this so, a sleeping person could not be awakened by the usual means—namely, a forcible external impression upon one or more of the senses.

Its inadequacy may be briefly illustrated by pointing out that it takes no note of one of the most salient phenomena of sleep—that the *will*, though not at all *suspended* therein, being easily recognized in dreams, altogether loses its rationality and its *control* over the workings of the mind as well as over those of the body.

The following may be set forth as an attempt at a reasonable and comprehensive definition, or rather description, of the conditions we find in sleep: Sleep is a state in which the impressions of external objects on the senses are *dulled*, but not annulled or suspended; in which the emotions, the imagination, the memory, and the will are but partially or even not at all suspended, and may even be intensified, while the *control* of the will over the emotions, the imagination, and the memory is wholly annulled,

together with its conscious control over the nerves of the voluntary muscular system. Reasoning power is annulled, but involuntary and instinctive muscular motions, and those arising from habit, still continue. Memory is certainly not annulled, or we should never dream of the past, of which we do dream largely.

The consciousness of Duration—that deepest of all mysteries—is not absent in sleep, but also passes wholly out of the control of the reason and the memory, and loses all relation to the conditions of waking experience, being often exaggerated or exalted far beyond these. Unconsciousness of duration occurs during the waking dream state, being here suspended at times, so that lapses of time remain unnoticed. Those subject to intense mental occupation, or to reverie, which is a species of waking dream, will attest this. Strong emotions also influence our consciousness and perception of duration.

It may be objected that the above description of sleep does not cover a species that general readers have been taught to consider typical—what is called "dreamless sleep." This, however, is probably a literary fiction. Even the "dreamless sleep of infancy" is not always realized, for healthy infants often present indications of dreaming. Sleep so deep as to be dreamless is probably not of the most natural kind, but rather the result of nervous, mental, or muscular exhaustion, or of drugs, being thus a more or less morbid lethargy.

No one would claim that natural dreams are symptomatic of morbid conditions, though of course certain kinds of dreams—as those from opium, of delirium tremens, dyspeptic nightmares, etc.—are such. These, moreover, are often a kind of waking dream, in which the body remains more or less awake while the mind is lethargic or deliriously excited.

It thus appears that sleep is far from being the simple affair it was held to be in the last century. On the contrary, it is a highly complex phenomenon, involving all the functions—mental, moral, and physical, and doubtless also physiological—of that most complex of all organisms, man. Hence, it must be worthy of far closer scientific study than it has yet received.

As to the physiological and chemical phenomena that accompany sleep in the animal economy: Of this—the most essential branch of the investigation—it must be stated that its cultivation has been very imperfect and inadequate. Still, enough is known to convince the present generation of *chemical* thinkers that sleep is by no means a subject for the psychologist alone, but will turn out to be physiological and chemical—that is, accompanied, and even almost altogether ruled, by chemical agencies and transformations. We have here a strong and sound basis for the hope of arriving at a control of natural sleep itself and at modes of influ-

encing and promoting its production without danger or detriment to general health. The few facts we have so far may be stated as follows: In healthful sleep the blood circulates more slowly; hence kidney action and perspiration diminish. The breathing is slower, and the exhalations of moisture and carbon dioxide from the lungs are less. Hence, these are doubtless produced in smaller amount, as they should be, from the diminution of muscular work and of combustion of animal fiber. And it is highly probable, though not yet fully tested by experiment, that certain gaseous, vaporous, or other products of the transformation of the muscles, nerves, and other tissues, partially stored up in the blood during working hours, are eliminated during sleep by the lungs, skin, and kidneys. The digestion is stated to be more active during normal sleep, and the temperature in the vital organs at least is stated by some authorities to remain at its normal point, though in the limbs it probably falls. This may be due to a tendency of the blood to the internal digestive organs. It is known, as was proved independently by Hammond and Durham, that the *volume* of the brain diminishes during natural sleep.

Returning to the old edition of the Encyclopædia Britannica (1779) before quoted, a few sentences possessing interest may be further taken from the article on Sleep. Referring back to the article on Dreams, it is here added: "Sleep we have shown to arise immediately from the communication between our sentient principle *and external objects being cut off*, in consequence of which memory is also lost, and the person becomes insensible of existence. This state may be induced either by such causes as affect the brain, the nervous system, or the blood, though it probably depends in most cases on the state of the vital fluid." This "vital fluid" or "vital spirit," as it is elsewhere denominated, is apparently not the blood itself, but an agent or influence then unknown, believed to reside therein. If we were now—with our present chemical knowledge—to substitute for "vital fluid" oxygen of oxyhæmoglobin of the arterial blood, this part of the citation would become rational. Oxygen, however, had then been discovered but four years previously, and its functions must have been yet but vaguely understood. The Italics have been introduced into the above excerpt to emphasize certain notions about sleep whose fallacy has been previously pointed out.

Dr. Hammond suggests that in the most profound natural slumber the spinal cord, with its nervous ganglia, remains awake, though not quite so much so possibly as when the brain itself is wholly conscious. Of course, the involuntary muscles, as those which operate the heart, the respiratory organs, etc., governed by ganglia of the spinal cord, never slumber. Their slumber is the last sleep of all. But Dr. Hammond cites proof independent of

this. The position of the sleeping person is often changed unconsciously when uneasy, and the feet, when chilled, will be drawn under the bedclothes. He mentions still more impressive facts, such as sleeping on horseback, without danger of losing seat, once the habit is acquired. We may add that men sleep leaning against a wall or a tree, or even astride of a limb, without serious risk of falling. Monkeys, opossums, and other animals sleep hung up by helices formed of their tails. Somnambulism may be referred to the same class of facts.

Prof. Michael Foster, of the University of Cambridge, England, a very eminent physiologist, says, in a work published in 1891, that although the phenomena of sleep are largely confined to the central nervous system, and especially to the hemispheres of the brain, the whole body shares in the condition. "The pulse and breathing are slower. The intake of oxygen and the output of carbon dioxide, especially the latter, are lessened. Indeed, the whole *metabolism*" (by which term he designates generally the chemical transformations in the living organism) "and the dependent temperature of the body are lowered." (The latter statement is not in accord with other authors.) "We can not say as yet how far these are the indirect results of the condition of the nervous system, or how far they indicate a partial slumbering of the several tissues." Prof. Foster distinctly declines to enter into what he calls "the psychology of sleep and dreams." But to ignore dreams and their essential relations to natural sleep suggests to the present writer the play of Hamlet with the Prince of Denmark left out.

Foster points out the fact, as the result of all experience, that the recumbent posture is highly promotive of natural sleep, and connects it with the reduction of energy consumed in the circulation, especially with the large diminution of work that falls upon the heart. The most remarkable and significant statements made by this high authority are that "during sleep the pupil is constricted, during deep sleep exceedingly so, and dilatation, often unaccompanied by any visible movements of the limbs or body, takes place when any sensitive surface is stimulated; and on awaking, the pupils also dilate." He adds that this "contraction of the pupils is worthy of notice, since it shows that the condition of sleep is not merely the simple and direct result of the falling away of afferent" (external) "impulses. When the eyes are closed in slumber, the pupils ought, since the retina is then quiescent, to dilate; that they are constricted, the more so the deeper the sleep, shows that important actions in the brain are taking place." In other words, as we have already set forth, certain inherent functions of the brain, also of the nervous system, emotional and imaginative processes, among others, independent of what he calls

"afferent" impulses from without, are still fulfilled. The nerves which govern the muscles of the iris must be so affected by the imagination (or by some unknown agent acting only during sleep) as to contract, as if light still fell upon them. This does not seem, however, to concur with the generally accepted view that the muscular fibers that control the iris are involuntary. Until these extraordinary phenomena are understood, we shall doubtless not arrive at a complete theory of sleep. The study of dream phenomena will in this connection (in spite of Prof. Foster) constitute an essential aid.

The collateral phenomena accompanying and related to sleep, though not confined to natural sleep—or, for that matter, to any kind of sleep that suspends the bodily functions—are several. Dreams are the most important and significant; but we can give space only to some partial consideration of the two species of dreams—namely, sleeping and waking dreams. Our encyclopædia of 1778 discusses several views then entertained regarding dreams; among them the curious one presented by the famous Richard Baxter, in his book on the Immateriality of the Human Soul, to the effect that dreams are due "to the action of some immaterial beings upon our souls." Objection is made to this on the ground that the existence of such immaterial beings is incapable of proof. This spiritualistic side of the discussion we must omit.

The most important suggestion regarding dreams made by this encyclopedist of 1778 is that *mania* and hypochondriasis are conditions under which the subjects dream while otherwise wide awake. That this is so appears incontrovertible, and we learn thence that the dream state does not necessarily arise from sleep, of the body at least. Mania may probably be defined as a dreamy slumber of the mind, without the participation of the body. Similar conditions are abundantly brought on temporarily by the abuse of certain powerful agents that destroy the rule of the will and reason over the mental functions, leaving the individual to be swayed altogether by the animal emotions. When the mania is chronic, accounts agree that in time the demoralization becomes, in most cases, so complete as to really give color to the views in ancient books, including our scriptural writings (and, moreover, in the works of some modern writers), that many if not most maniacs are under demoniacal possession. Waking dreams and reveries are known also to attack many persons in whose minds imagination is a predominating element. And even such as do not belong to this class, may become, when under the influence of great distress, fear, privation, or hardship, subject to such waking visions. Starvation or thirst, or both, have often produced the most remarkable illusions. One interesting example may be cited which is historical. It is found in the Journal of Strain's Ex-

ploration of the Isthmus of Darien in 1854,* many of the members of which perished slowly and horribly from sheer hunger (thirst not being a factor in this case). The following paragraph is given as an illustration:

"From the time that food became scarce to the close, and just in proportion as famine increased, they did not gloat over visions of homely fare, but reveled in gorgeous dinners. So strangely and strongly did this whim get possession of their minds, that the hour of halting, when they could indulge undisturbed in these rich reveries, became an object of the deepest interest. While, hewing their way through the jungles, and wearied and overcome, they were ready to sink, they would cheer each other up by saying, 'Never mind, when we go into camp we'll have a splendid supper,' meaning, of course, the imaginary one they designed to enjoy. Truxton and Maury would pass hours in spreading tables loaded with every luxury they had ever seen or heard of. Over this imaginary feast they would gloat with the pleasure of a gourmand, apparently never perceiving the incongruity of the thing. They would talk this over while within hearing of the moans of the men, and on one occasion discussed the propriety of giving up in future all stimulating drink, as they had been informed it weakened the appetite. As hereafter they designed, if they ever got out, to devote themselves entirely and exclusively for the rest of their lives to eating, they soberly concluded that it would be wrong to do anything to lessen its pleasures or amount."

"Absence of mind," of the results of which such remarkable stories are current, must be cited also as an example of a transient waking dream or species of reverie state.

Under the next head a few words may first be expended upon the class of lethargies or comatose sleeps arising from certain diseases, such as apoplexies, epilepsy, paralysis, catalepsy, etc. These have but remote analogies with natural sleep. In most of them the brain, instead of being in the collapsed condition, partly drained of blood, which occurs in real sleep, is overloaded and congested with blood, and the resulting stupor is mostly absolute and dreamless. Syncope or fainting has one point of analogy with sleep—namely, that it is accompanied by cephalic anæmia, or loss of blood from the brain; but this goes so much further than in sleep, and the other symptoms, of decrease of general circulation and of respiration, are so great, that there is no further analogy. The insensibility of every sort during syncope is often absolute. Paralysis may in some forms be regarded as a death-

* A great part of this journal may be found in Harper's Magazine in 1881 (or thereabouts).

like slumber of the body while the mind remains awake. The sleep from the action of excessive cold, which precedes death, is due, of course, to general retardation of the circulation, which in due time affects the brain, but probably has but a partial analogy with natural sleep. It has not been sufficiently examined to determine whether dreams accompany it at any stage. The delusions from the abuse of opiates and those of delirium tremens are of the class of waking dreams. Death by drowning is asserted to be preceded by extraordinary waking dreams, sometimes rather pleasurable than otherwise.

The most important of all species of sleep for our present purposes of comparison are those produced by anæsthetic agents. The general use of these is now but about half a century old, though it has been shown that the principle of anæsthesia and its use in surgery, etc., is about as old as the Christian era. Dioscorides describes the use of the *mandragora* root, steeped in wine, as an anæsthetic drink to produce a sleep in which painless amputations and other surgical operations could be effected. Pliny and Apuleius (author of the famous Golden Ass) each make similar statements. Sir B. W. Richardson announced, in 1875, that he had experimented with mandragora, and had largely confirmed the ancient stories about it. The moderns have a great number of anæsthetic agents, some of which are permanent gases, others volatile liquids, which are mostly administered by inhalation; but we yet know very little, in exact scientific detail, about most of them. Some, when given in properly graduated doses, furnish us with conditions approaching closely to those of natural sleep, generally of a dreamless kind; but others, if given in small doses, furnish us examples of sleep of the will power and reasoning functions, accompanied by emotional dreams and hallucinations. In the case of *nitrous oxide* (laughing gas), especially when given in moderate doses, mixed with air or oxygen, emotional excitements of the most remarkable kind result. The subject will often fly into an energetic rage, manifesting a violent and ludicrous pugnacity toward those about him. Others will *declaim* in an oratorical manner, sometimes sensibly and coherently. Of such occurrences the subject often retains vague memories, like those of natural dreams. Thus memory persists during the action of this agent, as in true sleep; and, as in sleep, the will-control is wanting. The natural instincts, no longer restrained, rise up and assert themselves. "*In vino veritas.*" Ordinary alcoholic intoxication, indeed, is but one kind of anæsthesia, and passes in its progress through the same characteristic stages or phases that have been previously defined.

The generalization remaining to be brought forward is as follows: It has already been indicated that of all the known arti-

ficial forms of lethargy, the premonitory stages of anæsthesia only are approximate in character to normal sleep. Nitrous oxide, with oxygen, is now largely administered to the point of insensibility, by distinguished physicians, to produce vicarious sleep, in cases of obstinate insomnia, and is regarded as a priceless remedy. But the lethargy thus produced is dreamless, and therefore not normal sleep. The mental and moral natures of the individual are in a condition of suspended animation, which, from what has been previously set forth, is an abnormally torpid condition of life. Further, it has been shown that *complete* anæsthesia itself differs essentially from natural sleep; for in the latter the senses are only dulled, and still remain more or less susceptible to strong external impressions, by dint of which wakefulness is readily brought about.

The question now arises, Is there any agent which exerts in small doses a sedative effect on both body and mind, an effect that increases with the dose or with the period of action, until entire insensibility finally results, and which, like nitrous oxide, works no permanent harm? The answer is that we have one such agent, *carbon dioxide* gas; itself a constant and copious *product* of normal animal life.

It is placed by Richardson, an eminent specialist on this subject, among anæsthetics, and this place is generally conceded to it. Even in the day of Pliny, its outward effects were familiarly known, as at the *Grotta del Cane*, near Naples. Popularly it is deemed a deadly poison, but many chemists have held that it is not so. In mines and deep wells it is usually unmixed with air, and the result of inhalation is, of course, speedy suffocation. Berzelius long ago stated that air containing five per cent can be breathed without serious injury. Dr. Angus Smith found, nevertheless, that one twenty-fifth of this proportion produced a slow diminution of the circulation, such as we have seen accompanies natural sleep. We have one experiment made by a commission on coal mines of the British Association, in which an animal exposed to carbon dioxide and air, *half and half*, a small jet of air being, however, continuously introduced to maintain a supply of free oxygen, lived "for a long time"—how long not stated. Here, plainly, rapid poisonous action is shown to be absent.*

* New facts have appeared since the above was written that add great strength to the positions taken here against the generally assumed highly toxical qualities of carbon dioxide —a body always present in the lungs and blood of men and animals. The experiments of Berzelius above cited—like all others of that unparalleled chemical genius—as to the toleration of animal life for important amounts of this supposed poison, stand now as being much more than verified. To wit, among others, an English experimenter, Mr. T. H. Wilson, has found that rabbits are uninjured by breathing for an hour air containing twenty-five per cent of the much-dreaded gas. At the last meeting of the British Association, Dr. J. S.

We have seen that during natural sleep the carbon dioxide expired (during wakefulness between three and four volumes per hundred of air from the lungs) diminishes as the circulation diminishes. Many claim that a succession of rapid but long-drawn respirations will quickly bring on drowsiness, and often sleep even ensues. This can be attributed only to a small over-charging of the circulation with carbonic acid. It must be recalled also that carbonic-acid waters and effervescent drinks generally produce with many a decided though transient sedative effect. But in this way doubtless none of the gas reaches the blood, except the little thrown off from the stomach by eructation, this being incidentally and partially inhaled. The gases contained in arterial and venous blood appear to vary somewhat. Several authorities agree, however, that the amount of free carbonic acid in arterial is much smaller than in venous blood, while the oxygen in the former (combined mainly with the hæmoglobin) is much larger. Pflüger made the free carbon dioxide, mostly in solution, in red arterial blood of a dog thirty-four volumes and a half per hundred, while in the blue venous blood it rose as high as fifty, or half the volume of the blood.

The generalization referred to is simply that normal sleep and sleepiness, or drowsiness, are due to a small increase over the average of the carbonic acid in solution in the blood, arising through its overproduction from the greater amount of muscular and other tissue that undergoes oxidation during the waking hours. During the sleeping hours this overload of the anæsthetic gas is gradually discharged until wakefulness results.

In this brief discussion no room has been occupied with what are called hypnotism, clairvoyance, trance, mind-reading, etc. These are outside of our scope—being, if authentic, not natural but supernatural phenomena, pertaining to the realms not of law but of miracle.

EXPERIMENTS, continued through many years, by Dr. S. Rideal, show that the chemical activity of sunlight during winter on the high Alps is much greater than at lower levels, and enormously greater than in large towns at the same season. This increased activity may contribute importantly to the beneficial effects of health of residence in such regions.

Haldane discussed the subject of the fatality to miners of "after-damp," hitherto believed to owe its effects to carbon dioxide. He shows that *absence of oxygen* is the real cause of death in these cases. He introduces the novel and highly rational suggestion that all parts of mines should be provided with reservoirs of highly compressed oxygen. A pint of this, he shows, would keep a man alive for an hour. Doubtless, with our present means and knowledge, oxygen could be stored in mines and elsewhere, in its *liquefied* form, for this and other valuable uses.—H. W.

THE GEOLOGY OF NATURAL SCENERY.

By FREDERICK J. H. MERRILL, PH. D.

IN this age of scientific progress, poets and prose writers may no longer tell us of "eternal hills" and streams which "flow on forever." The science of earth-knowledge shows that the mountains are but creatures of yesterday in geologic time, and to-morrow may be cast into the sea through the agency of that wondrous source of power, the sun. Moreover, as the study of Nature advances, the veil of superstition is torn aside and the mystery is dispelled in which ignorance involves the causes of natural phenomena; so that to the mind a broader field of view is opened, while the knowledge of the changes which have occurred and are taking place about us on the earth adds much to the inspiration which beautiful scenery gives, without detracting from the poetic quality of the feelings it excites.

Foremost among the minds which have felt this inspiration and expressed their pleasure in the English tongue are those of Byron and Sir Walter Scott. But, in their time, truth in description of natural phenomena was not expected. The poet interpreted at will the scenes which impressed him, and the reader, charmed with the rhythmic cadence of the lines, was content to admire the beautiful clothing of the writer's thought, little caring whether the phenomena were truthfully described or properly explained. But from the writers of the future we must expect a reconciliation between scientific truth and poetic fancy.

It is fallacious to claim that natural science bridles too closely the poetic mind. Science is but truth, and what is not true has no part in science. Surely, in the presence of the most famous works of man the knowledge of their history in no way detracts from the interest which they inspire. Mountain and valley, hill and plain, river, lake, and sea, have each their history for the observer to read; and instead of imagining convulsions of Nature and picturing speculative catastrophes, the mind may dwell on the action of simple and familiar agents working through long ages and bringing about by slow degrees that beauty and grandeur of terrestrial form which is never caused by cataclysms.

To instance this hypothesis we need not journey far; our own land is rich in scenery unsurpassed, and whether we seek our illustrations in Rhineland or the valley of the Hudson, among the Alps or the Sierras, we are only turning the pages of one great book. But though the turning of those pages might go on forever, and though the most earnest student can never know their number, the history which they contain is intelligible to all

who would know it, infinite in the variety of its expression and charming in the simplicity of its style.

Among the varied scenes which charm the eye there are none so pleasing as those which combine both land and water; and the vicinity of New York city, with its varied and rich combination of water and landscape, will serve as a fitting example to introduce the subject.

In order to consider the origin and history of this scenery, it is necessary to look backward a short distance in geologic time. Ten thousand years or more ago the continental glacier extended from the highlands of British America southward to Long Island, and at its margin, where it may have been a thousand feet or more in thickness, accumulated a mass of rock *débris* brought in part from northern New York and New England. When the advent of a warmer climate caused the ice sheet to retreat, its terminal mass of *débris*, called by geologists the *moraine*, formed a range of lofty hills, locally known on Long Island as the "backbone," and which crosses Staten Island, northern New Jersey, Pennsylvania, and Ohio, continuing northwestward far beyond the Mississippi.

The land was then much depressed to the northward, and the waters of the ocean communicated with New York Bay through the valleys of the St. Lawrence, Lake Champlain, and the Hudson. In place of Lake Champlain was a great estuary, its surface four hundred feet above the present tide level, stretching from the foothills of the Adirondacks on the west to the Green Mountains on the east, and of which the beaches with their sea shells may still be found. Into the estuary which occupied the valley of the Hudson the streams from the surrounding country brought their sediment, gradually forming deposits of clay and sand, while on the outer shores of Staten and Long Islands the ocean waves broke sixty feet or more above their present level. Gradually the continent rose from its submergence, the elevation of the land caused the ocean to retreat, and the Hudson, the Mohawk, and their tributaries sought an outlet southward to the sea. The rivers thus revived cut a channel in their seaward journey deeper and deeper through the sand and clay deposited in the Hudson Valley, and near the end of their united course carved through the moraine a passage which we call the Narrows.

When Long Island Sound is viewed from the Westchester shore the lofty hills of the moraine form a most picturesque background to the blue waters of that beautiful estuary which but for the advent of the ice sheet would probably have been separated from the ocean only by a low, sandy plain. From the summit of the moraine in Prospect Park, Brooklyn; from Harbor Hill, or from any of the numerous eminences on Long

Island, the widespread view of sea and land impresses itself upon the observer, and in every way in which this range of hills is brought to our notice we are unconsciously led to appreciate the scenic importance of this legacy of the continental ice sheet.

From the scenery of Long Island Sound and the moraine one may turn to that of the Hudson River.

On the east shore of this noble stream is a terrace, picturesquely dotted with handsome country seats, which extends almost continuously from New York to Peekskill, and, after a brief interruption where the steep slopes of Anthony's Nose and the Dunderberg form the lower gate of the Highlands, reappears at Garrison's and Cold Spring and forms the plain upon which the Military Academy is located at West Point. This terrace is about seventy-five feet above tide at the Riverside Park in New York city, and increases in height northward to about one hundred and twenty feet at the State Camp near Peekskill and one hundred and eighty feet at West Point. North of the Highlands the remnants of terraces may be seen on both shores of the river as far as Troy and throughout the valley of Lake Champlain, increasing in height northward to the St. Lawrence River, where, in the vicinity of Montreal, they have an altitude of over five hundred feet.

In these terraces is recorded ineffaceably the history of the continental submergence previously mentioned. They are the remnants of the deposit of sand and clay formed in the Hudson and Champlain Valleys when submerged, and the surface of the highest terrace indicates approximately the old sea level.

These terraces, relics of Quaternary subsidence, are not, however, the only interesting geological phenomena to be seen along the valley of the Hudson. The bold, precipitous Palisades, known as widely as the river which they overlook, call our attention to a period of volcanic activity in Mesozoic time. These lofty cliffs form the margin of a sheet of trap or igneous rock, three hundred to four hundred feet in thickness, which was forced to the surface in a molten state between the beds of red Triassic sandstone which form the eastern border of northern New Jersey and of Rockland County, New York.

Throughout most of its extent the Palisade range has been leveled off by wave action at some remote period of subsidence, while immediately west and north of Nyack a portion which has escaped erosion rises in high peaks with irregular outlines.

Leaving the Palisades behind us, we enter the gorge of the Highlands. The rocks which form these rugged steeps are of the oldest and hardest in our State. Though they have yielded to the cutting of the river current in past ages, they resist the degrad-

ing influences of the atmosphere and rear their summits far above the surrounding country.

When Storm King is passed in our northward course, the scenery changes completely. The gneiss hills of Westchester County, abruptly rolling to the east, the craggy Palisades and the Highland mountains give way to a region of moderate elevation and gently rolling surface, abruptly notched by the river valley. This is a belt of slate and limestone territory extending from Vermont to Alabama, and of world-wide fame in its fertility, known in Pennsylvania as the Great Valley, and in Virginia as the Valley of the Shenandoah.

From Cornwall to Troy the scenery of the Hudson shows but little variation, as the geology does not change materially except where the hard Catskill sandstones and conglomerates rear their lofty pile, furrowed, channeled, and notched so deeply and widely that of the original plateau only the present mountain remnants may be seen.

As a geological map of the Hudson Valley would tell what variety of scenery might be expected, so one may forecast the scenic pleasures of the Rhineland without entering its territory.

From Basle to Mainz the Rhine flows through a low plain of Quaternary age. In this portion of the valley the natural scenery is monotonous, varied only by distant views of hill country. From Biebrich to Bingen the river skirts the foot of the Rheingau, which affords on the right bank the picturesque scenery of that famous vine-clad slope. From Bingen northward the river has abruptly cut its channel through the Devonian rocks which extend from Bingen nearly to Bonn, and, in meandering through the defiles of its valley, exhibits to the traveler a variety of imposing scenery which in remote centuries as well as in recent times has inspired the poet and the minstrel, and in the richness of its historic associations and its relics of the feudal system is unsurpassed and probably unequaled by any other valley in the world. From Bonn to the sea the country bordering the river is of more recent origin and proportionately deficient in relief and scenic variety.

In connection with these instances may be stated a general principle of the relation of scenery to geology: the older the formation, the higher its relief and the more striking its scenery.

To exemplify this principle in its broadest form let the reader compare the topography of some of the newest and oldest formations. For instance, compare the London basin with the Scottish Highlands, or Dover Cliffs with Mount Snowdon, or the drift hills of Long Island with the Adirondack peaks, or the sand plains of Florida, Georgia, and the Carolinas with the mountain

region about Asheville. The most inexperienced observer can not fail to note the contrasts.

To this rule, as to all others, there are exceptions. Some of the highest mountains of the world are composed of Tertiary rocks, and volcanic cones, which vary greatly in age, are characterized by similarity of form.

The dependence of scenic contrast on geologic age may well be exemplified along another well-beaten line of travel.

If we journey from Paris to Lausanne we find the Tertiary plain of France comparatively monotonous; but in crossing the Jurassic rocks between Tonnerre and Dijon we find them deeply incised by valleys, adding much to the picturesqueness of their scenery by their high relief. At Dijon we are on the western margin of the valley of the Saone, a basin filled with Tertiary and Quaternary sediments and comparatively uniform in surface. Crossing the Saone Valley we ascend the slope of the Jura Mountains, pass their summit, and when we descend their eastern flank, from the southeast there bursts upon the eye a vision of serried mountain peaks, lofty, abrupt in outline, and in most cases capped with snow, looking like curling breakers in a stormy sea. This is the Bernese Oberland. Of this well-known Alpine chain the highest peaks are formed of rocks very old in geologic time. Passing southward beyond the valley of the Rhone we may cross the Pennine Alps by the Simplon Pass and descend to the Quaternary plain of northern Italy. Here the contrast is abrupt and easily observed, as is the change from the mountain region of Tyrol to the plain of Bavaria about Munich.

To multiply these instances is unnecessary; the writer's object is only to explain these scenic contrasts which have been seen by every intelligent observer. In our own country the Atlantic coast plain and the flat sedimentary plains of the Mississippi basin differentiate themselves from the Appalachian mountain region, and the plutonic masses of the Adirondack chain stand out in bold contrast to the glacial and post-glacial deposits of the western portion of this interesting wilderness. So in the Rocky Mountain region the central masses of Archæan rocks stand out in strong relief above the later formations which border them.

To elaborate this subject in detail would be to write the geology of the whole world, a task from which the writer refrains.

FROM the fact manifest in the Alps that glaciers rarely form till the mean annual temperature falls below 27° Fahr., Prof. T. G. Bonney estimates that a fall of 20° Fahr. would produce large glaciers in the hill districts of Britain; one of from this to about 12° Fahr. would bring them back in the various districts on the globe where traces of them have been observed, and in some of these the small size of the vanished glaciers shows that the fall can not have exceeded about 15° Fahr.

GEOLOGIES AND DELUGES.*

By Prof. W. T. SOLLAS, F. R. S.

IN the days when geology was young, now some two hundred years ago, it found a careful foster-mother in theology, who watched over its early growth with anxious solicitude, and stored its receptive mind with the most beautiful stories, which the young science never tired of transforming into curious fancies of its own, which it usually styled "theories of the earth."

Of these, one of the most famous in its day and generation was that of Thomas Burnett, published in 1684, in a work of great learning and eloquence. Samuel Pepys, of diary fame, is said to have found great delight in it, and it is still possible to turn to it with interest when jaded with the more romantic fiction of our own day.

It was the fashion to commence these theories with chaos, and chaos, according to Burnett, was a disorderly mixture of particles of earth, air, and water, floating in space; it was without form, yet not without a center, a center indeed of gravity, toward which the scattered particles began to fall, but the grosser, on account of "their more lumpish nature," fell more quickly than the rest, and reaching the center first accumulated about it in a growing heap, a heap, as we might now express it, of fallen meteorites; the lighter particles, which form fluids, followed the heavier in their descent and collected around the solid kernel to form a deep ocean. This was at first a kind of emulsion, like milk, formed of oily and watery particles commingled, and, just as in the case of milk, there separated on standing a thick, creamy upper layer, which floated on the "skim milk" below. That this really happened, the good Burnett bravely remarks, "we can not doubt." The finest dust of chaos was the last to fall, and it did not descend till the cream had risen; with which it mingled to form, under the heat of the sun, the earth's first crust, an excellent but fragile pastry, consisting of fine earth mixed with a benign juice, which formed a fertile nidus for the origin of living things. Outside nothing now was left but the lightest and most active particles of all, and these "flying ever on the wing, play in the open spaces" about the earth, and constitute the atmosphere of air.

Such was the earth when first it formed the abode of unfallen man—perfect in form and beauty, for it was a true sphere, smooth as an egg; undisfigured by mountains, and unwasted by the sea. It was unfortunately but too like an egg, since its fra-

* British Association address to workingmen.

gile shell rested on the treacherous waters of the interior abyss, "the waters under the earth," and the sun overroasting, finally cracked and burst it; the broken fragments of the ruined world fell downward into the abyss, and the subterranean waters rushed out in a mighty flood to remain as our present seas and oceans, from which the broken crust protrudes as continents and islands. As might naturally be anticipated, the bursting out of the abyss corresponds to the Noachian deluge, which we thus perceive to have been profounder in its origin and wider reaching in its effects than we might previously have supposed. This, for distinction, we may call Burnett's deluge; of his geology we may say that it is cosmological, since it endeavors to trace the history of the earth backward to its origin in chaos; that it is catastrophic, because it attempts to account for all the great features of the earth by a single event which occurred suddenly and with violence; and that it is theologic, since it owes its inspiration to Holy Writ.

As geology grew older it went to school: what was the name of the school is not quite certain; some have called it "Science falsely so called," others more briefly, "Inductive Science." However this may be, the immediate effect on the manners of young geology was very distressing. It grew contradictory, and was frank in the expression of obnoxious opinions. One of its most irritating remarks was that the world was not made in a week, and it would appear that at this time the relations of child and foster-parent became not a little strained. Still, geology proved an apt scholar, and its progress was rapid. One of the most important lessons it learned was that if we want to know how the world was made, the first essential is to study the earth itself, to investigate with patient drudgery every detail that it presents, and particularly the structures that can be seen in river banks, sea cliffs, quarries, pits, and mines. Thus it discovered that the solid land beneath our feet is to a large extent composed of layers of sediment which were once deposited more or less quietly at the bottom of ancient seas, and certain curious bodies known as fossils it concluded to be the remains of plants and animals, seashells and the like, which were once the living denizens of these seas.

It discovered that these deposits lie so regularly, one upon another, that it compared them to a pile of books, or to a slanting row of books lying cover to cover; and that in some cases, at least, the simile was not strained, will appear if we trace the structure of England from Oxford westward toward Bristol. We then find that the thick bed of clay upon which Oxford stands lies evenly on a series of gently sloping beds known as the lower Oölites; these in like manner repose on those thin

seams of limestone and clay called the Lias, and these in their turn upon the red beds of the Trias. It might perhaps have been expected that this uniform arrangement would continue through the whole thickness of the stratified rocks, but it was discovered, and the importance of the discovery was recognized so early as 1670 by Bishop Steno, a man of great genius, that the regularity of the successions is liable to interruption at intervals. Thus as we approach Bristol we encounter those beds of limestone which are associated with our coal-bearing strata, and which are consequently called "carboniferous"; but these are by no means related to the beds we have just passed over in the same manner as they are to one another—we do not find the highest bed of the carboniferous series offering its upper surface as a gently sloping platform on which the trias may rest; on the contrary, the carboniferous beds are seen to lie in great rolling folds, with the tops of the rising folds absent, as it were sliced off, and it is on the edges, not on the surface, of these beds that the red trias layers are seen to be spread out. This sudden change in disposition may well be called a break in the succession of the rocks, and, as if to emphasize it and compel attention to it, we find it accompanied by a complete change in the character of the fossils, those occurring in the carboniferous rocks being of entirely different kinds from those which are found in the overlying beds.

Evidently the carboniferous beds could not have been laid down in the sea in the steeply folded form they now present; at first they must have been spread out in nearly horizontal layers, and the folded form must have been subsequently impressed upon them, no doubt by the action of some stupendously powerful force. Subsequent also must have been the removal of the upper parts of the folds and the general planing down which they appear to have undergone.

To the young geology all this might seem perfectly clear, but in its impulsive explanations it assumed that Nature must have frequently acted in a great and terrible hurry: thus the folding of the rocks was supposed to have been produced suddenly and violently by a single mighty convulsion, which simultaneously changed sea floors into mountain chains, split open the land in wide-gaping chasms—our present river valleys—and with the same blow destroyed every living inhabitant in the world.

But the discordance between two sets of rocks is met with not once only, but several times, in the stratified rocks of the earth's crust, and for every discordance there must have occurred a corresponding catastrophe.

These catastrophes were as wonderful as Burnett's, and there were more of them, so that at this stage of its existence geology was appropriately designated "catastrophic." It had completely

severed the apron-string, and ceased to be theologic, but it still to its credit remained cosmologic. It traced the earth from chaos up to a stage when islands and continents rose out of a primeval ocean, the waters of which were boiling; saw it peopled with strange and various forms of life, and watched it run its course, rejoicing in the sun, "cheerful, fresh, and full of joyance glad," then pictured it overtaken with disasters, shaken with earthquakes, overwhelmed by floods, and agonizing in the labors of a new birth. Calm followed after storm, and life rejoiced afresh in a remade world to be again destroyed. Thus, through alternations of peace and strife, the earth moved on its changeful way, to the crowning creation of man, who was himself a living witness of the last great catastrophe of all, the Noachian deluge. Its waters covered the whole earth, to the tops of the highest mountains under heaven, and on their retreat they left behind, as a standing witness to their extension, great sheets of sediment, supposed to be spread out over the entire surface of the globe, and appropriately named the "diluvium." The diluvium may be seen in most parts of the British Isles, except in the south of England; it consists of clays and sands, containing vast numbers of curiously scratched stones.

As the powers of geology matured it became increasingly able to dispense with catastrophes. The very diluvium itself was shown to be local in its distribution, and glacial in its origin; masses of moving ice, like that which buries the greater part of Greenland out of sight, covered a large part of the temperate regions, and this it was that produced the curious scratched stones; and the deposits containing them, which are consequently no longer called "diluvial" but "glacial." More important yet, land could be shown to be still actually rising from the sea, and mountains growing into the air, but so slowly that the fact was not established without much dispute, which is hardly yet over. Valleys could be shown to result, not from any bodily fracturing of the land, but from the slow wearing action of the rivers which flow through them, and the waves of the sea were shown to be capable of cutting down cliffs and of reducing the land to a plain.

From these facts the discordance in the succession of stratified rocks found an easy solution. Recurring to the instance of the carboniferous rocks and their relations to the trias, we no longer need suppose that the stupendous force which folded the carboniferous rocks and raised them into the air acted suddenly or even very rapidly; judging from the rate at which mountains rise now, their upheaval may have proceeded slowly; a few feet in a century would suffice. If we allow but one foot in a century, it would only require two million years to produce a mountain range twenty thousand feet in height. The movement might

naturally be expected to be accompanied by earthquakes, but there is nothing to lead us to suppose that these would be on a much grander scale than those of the present. During its slow elevation, the mountain range would be exposed to wind and weather, rain and rivers would carve it out into ridges and valleys, and frost would splinter its peaks into spires and pinnacles. Subsequently it would sink beneath the sea, and the waves of the sea, as they battered down its cliffs, would remove the last remnants which had escaped the rain and rivers, and roll over an unbroken plain. On this plain, as it continued slowly to subside beneath the sea, the immense deposits of the trias, lias, lower oölites, and Oxford clay would be piled up.

If the rise of the sea floor into the Bristol Alps took place slowly, and involved a great lapse of time, so equally did the sinking of the land to form the sea floor afresh, and in this long interval time was afforded for great changes in the organic world; and thus we reach an explanation of the great and striking differences which distinguish the fossils of the carboniferous rocks from those of later date.

There is no insuperable difficulty in this explanation; its great merit lies in its accordance with the course of Nature as we observe it at the present day; and henceforward it became the motto of geology that the processes of the present furnish the key to the interpretation of the past. The changes in which the life of the earth is manifest are not only slow and gradual now, but they have ever been the same. The earthquakes, which in ancient times shook the land, were no more violent than those of which we have lately read in the daily newspapers; the ancient volcanoes were not more terrible in their outbursts than Krakatoa; floods were not more appalling than those which still from time to time sweep away tens or even hundreds of thousands of human beings from the Ganges plain, and the earth, instead of falling into convulsions every now and then, proceeds on the even tenor of her way, without haste and without rest, preserving a uniformity in her progress which impresses us with its solemn grandeur, but which sometimes seems a trifle monotonous. From its belief that an unbroken uniformity in the operations of Nature extends from the present into the most remote past, geology now came to be called "uniformitarian." It was no longer theologic, no longer catastrophic, and, I am sorry to add, no longer cosmologic. It persistently refused to inquire into the early history of our planet, and restricting its study to the accessible parts of the earth's crust, it abdicated its regal position as the science of the earth, and became as it were a mere petty chieftain, dealing only with rocks and the fossils they contain; the fossils, by the way, not rightly belonging to its province at all.

And it was because it passed from being a science of the earth to become a mere study of rocks and fossils that Hutton was able to make his famous declaration that as a result of his inquiries into the system of Nature he could discover "no vestige of a beginning, no prospect of an end." Apart from this, however, and in its self-limited career, geology pursued a luminous advance, and as it did so the Noachian deluge began to sink into an oblivion which it might be thought to have scarcely merited. For if the biblical account is to be taken literally, it furnishes us with a catastrophe of the first order; and since it is said to have occurred comparatively recently, or at least in historic time, the uniformitarian, by his own principles, would have been compelled to infer, as the catastrophist had done, that such deluges form a part of the orderly scheme of the world. The universality of the deluge had, however, for various reasons, been denied, not only by geologists, but by writers of other schools of thought, and toward the middle of the century belief in it among the learned was gradually expiring; such a number and variety of convincing arguments as converged against it could indeed but lead to that result; and that the deluge, so far from being universal, was a local and very local phenomenon, became an article of belief so settled among all good geologists—and I think I may add theologists—that it may be said to have finally fallen into the deep slumber of a decided opinion, from which I for one have no desire to arouse it.

Thus the deluge, so far from shaking the uniformitarian position, was rather itself submerged by uniformitarian views, and growing geology was in danger of taking the uniformitarian formula for an infallible dogma. It was saved from this by physics, a clever brother of its own, which had now discovered the famous principle of the "conservation of energy," and another equally famous, "the dissipation of energy." From these it was deducible that the duration of the earth as a living planet must be strictly limited in time. It must have had a beginning, and at the beginning was furnished with a store of energy, which it has ever since been spending. In this spending of energy its life consists, and when the store is at length exhausted its life will cease, and it will become numbered among the dead planets.

A good deal of this uniformitarian geology might perhaps itself have guessed, had it extended its views beyond rocks and fossils to the stars and other shining bodies which people the vast realms of space. The present, then, strange to say, will still afford a key to the past. We have but to turn to the sun, our nearest luminary, though still more than ninety millions of miles away from us, and in that great orb we find much to suggest the state of our planet some ninety millions of years ago or more.

It is scarcely necessary to remind you of the fact that the sun is a body so hot that the most refractory substances known to us on the earth exist in it in a state of gas or vapor; tongues of glowing gas shoot from it like flames; the clouds which emit its brilliant light are probably clouds of carbon or silicon, which have momentarily condensed from a gaseous state; and rain, if rain ever occurs, must be a rain of molten metals, such as iron, which will be dissipated in gas before it has fallen very far.

If we proceed to the more remote nebulæ, largely composed of glowing masses of gas, we find a suggestion of a stage more embryonic still, when the earth had as yet no separate existence, but formed, with its sister planets and the sun, a single shining cloud. On the other hand, if we turn our gaze on our nearest relative—offspring possibly—that dead planet, the moon, we may read in its pallid disk the sad reminder, "Such as I am, you, too, some day will be."

But this was not all that was contained in the admonition of physics; it showed not only that the earth is mortal, but that its span of life, as measured in years, or millions of years, is brief compared to the almost unlimited periods which geology had been in the habit of postulating. If catastrophic geology had at times pushed Nature to almost indecent extremes of haste, uniformitarian geology, on the other hand, had erred in the opposite direction, and pictured Nature, when she was "young and wantoned in her prime," as moving with the tame sedateness of advanced middle age. It became necessary, therefore, as Dr. Haughton expresses it, "to hurry up the phenomena."

With its uniformitarianism thus moderated, geology has again become cosmologic, and, neglecting no study that can throw light on any question connected with our planet, has regained its position as the science of the earth: it is henceforth known as evolutional geology.

The change has not taken place without occasional relapses into catastrophism. Some indications of this can, I fancy, be perceived in the writings of that eminently great geologist Suess, who, among other suggestions savoring of heresy, has lately recalled attention to the "Deluge," and endeavored to show that though certainly local, and indeed confined to the Mesopotamian Valley, it was on a grander scale than we had been accustomed to suppose, or, in plain language, a genuine historic catastrophe.

A local flood must have had a locality, and the clew to this is furnished by Genesis itself, which informs us that Abraham, the founder of the Hebrew race, left his ancestral city, "Ur of the Chaldees," at a time long subsequent to the flood; it is, therefore, rather in the land of the Chaldees than in Palestine that we should be led to seek the scene of this momentous tragedy.

This land is no other than the famous and once beautiful valley of Mesopotamia, through which the great Euphrates and arrow-swift Tigris flow to empty themselves into the Persian Gulf. Almost lost sight of for a while, interest in it was reawakened some seventy years ago by the investigations commenced by Mr. Rich, and followed up with such wonderful results by Botta, Place, Layard, George Smith, and others. Their discoveries have revealed to us in unexpected fullness the details of a complex and advanced civilization almost if not quite as ancient as the Egyptian, and far more profoundly interesting, for the ancient nations of Mesopotamia are the intellectual forefathers of the modern world. The learning of the Chaldees was the heritage of the Jews and Greeks; from these the torch was handed on to the Romans, and Jew and Greek and Roman inspired, and still inspire, for good and evil, the civilization of the nineteenth century. There is much more of the Chaldean in every one of us than we are given to imagine.

The people whom we find in possession at the dawn of history were Semites, the parent stock from which the Jews subsequently branched off; and one has but to glance at their faces and forms, as portrayed in their statues and pictures, to recognize the strong family likeness, while the emphasis with which muscular development is expressed in parts of the human figure suggests that the remarkable assertion, "The pride of a young man is in his legs," was a Semitic opinion long before the time of Solomon.

Just as Egypt is the gift of the Nile, so is Mesopotamia equally the gift of the Tigris and Euphrates, for it is built up of the mud brought down from the mountains by these two streams into the Persian Gulf, which is thus in process of obliteration. So long as the two great rivers were not regulated, they produced terrible floods in the wet season; and one of the earliest works of the Chaldeans was to control their flow by great dams, and by diverting a part of their water into canals. These canals covered the country like a network, and served not merely to ease the rivers, but also to irrigate the land, which, thus richly supplied by water, became, under the hot sun, so fat and fruitful that corn is said to have borne three hundred fold. Groves of palms, orchards, with grapes and many other luscious fruits, were cultivated, while the pastures supported abundant flocks and herds. It was a true garden of Eden, and differed chiefly from the biblical paradise, which Delitsch thinks was actually situated within this garden, in the fact that even here man had still to earn his bread in the sweat of his brow. This the Turks, who now possess the country, have no inclination to do, and consequently it is rapidly returning to its primitive desolation. Were England as enterprising as she was in the time of Elizabeth, we should rent this land from the Porte,

run a railway through it, and thus shorten our route to India by a thousand miles, farm it, and thus provide ourselves with one of the richest granaries in the world.

In a land so favored, it is nothing wonderful that the inhabitants teemed in millions, villages were everywhere dotted about, and in their midst great and flourishing cities arose—Ur, the City of the Moon-god; Erech, the City of Books; Nippur, and, most famous of all, proud Babylon, "the Gate of God," which stood on the left bank of the Euphrates, some two hundred and eighty miles above its present mouth. In early times, probably about 2300 B. C., the Jews left this beautiful land for some unknown reason, and after various vicissitudes settled in Palestine. Another branch of the Chaldean stock migrated in later times to the northern part of the Tigris Valley, where they built many mighty cities, and founded the warlike kingdom of Assyria. Of their cities it is sufficient to mention Assur, which gave its name to the kingdom, and Nineveh, which afterward became the capital.

The Mesopotamian plain, owing to the way in which it has been produced, is an almost dead flat, and offers no natural elevations for building; the Chaldees, therefore, to raise the foundations of their palaces, temples, and houses above the reach of floods and fever, and for better defense against their enemies, constructed, with incredible labor, great mounds, by piling together quantities of sun-dried bricks and rubbish, and building round this a thick wall of burned bricks, well cemented together. Some of these mounds, as that of Kojundjik at Nineveh, are as much as sixty feet in height, and it has been computed that this mound alone would have required the labor of twenty thousand men for six years in its construction. But there was never any difficulty in obtaining all the labor that was wanted. Prisoners of war were compelled to work under the stick, and the building of mounds was one of the wholesome occupations to which the Jews were set during their captivity in Assyria.

On the mound of Kojundjik stood two great palaces, one of them that of King Assurbanipal. It was evidently not merely a royal residence, for one of its chambers at least was devoted to public purposes; this was the king's library, to which the citizens, who were taught in their early years to read and write, had free access. Whether any of the books were written on papyrus is uncertain; all that have survived the conflagration, in which the palace was destroyed, are on tablets of kiln-made brick. Of such tablets many thousands have been recovered, not only from Nineveh, but from other towns, and many of them are now preserved in the British Museum. Thus within the last fifty years modern Europe has obtained a glimpse, and more than a glimpse, into the literature of a civilization that perished just as

the Roman was coming into existence; for, as Sir Walter Raleigh puts it, "In Alexander's time learning and greatness had not traveled so far west as Rome, Alexander esteeming of Italy but as a barbarous country, and of Rome as but a village. But it was Babylon that stood in his eyes, and the fame of the East pierced his ears."

The recovered literature covers a vast field of human interest, in science, as in astronomy and mathematics, particularly in astronomy, for the Chaldeans were famous star-watchers, and had already named the stars and constellations, associating them with the deeds and mighty works of their heroes and demigods, so that the starlit sky became a pictured dome, and the zodiac a frieze to the Assyrian, reminding him of history or fable, like the sculptures and paintings which adorned the king's palaces; in religion and poetry, and in commerce, many of the tablets recording business contracts, and revealing a system of mortgage and banking, money being frequently lent at from thirteen to twenty per cent, which was moderate; for the advantages of cent per cent were already known and appreciated by these simple Semitic folk.

It was among the tablets from King Assurbanipal's library at Nineveh that George Smith, now over twenty years ago, made a famous discovery. He found a fragment of a tablet, bearing words, which he deciphered as follows: "On the Mount Nizir the ship stood still. Then I took a dove, and let her fly. The dove flew hither and thither, but finding no resting place, returned to the ship." Every Englishman who knows his Bible would have guessed, as George Smith immediately did, that he had before him a piece of a Chaldean account of the deluge. He searched for more fragments, and found them. He went out to Assyria, visited the king's palace, and found still more tablets and pieces of tablets, some of them just those he required to fill up missing gaps in the story. Since its first translation by its discoverer it has been again translated and retranslated by some of the acutest scholars in Europe, so that we now possess a fairly complete knowledge of it; a few missing words or even lines, and occasional obscurities occur, but these are of no great importance. In a town which has the privilege to number the distinguished Assyriologist, Prof. Sayce, among its residents, there will be no necessity to present the story more than briefly. It runs as follows: Sitnapistim, the Chaldean Noah, is warned by Ea, the god of wisdom and the sea, that the gods of Surippak, a city on the Euphrates, even then extremely old, had decided in council to destroy mankind by a flood. Sitnapistim is told to build a ship in which to save himself, his family, household, and belongings. Anticipating the curiosity of his neighbors, since he had never before built a boat, he asks what answer he is to make

when questioned as to his unusual proceedings. Ea, who as the god of wisdom is naturally a master of evasion, provides him with a subterfuge, and Sitnapistim sets about building his boat. He forms it of timber and reeds, and makes it watertight by filling up the crevices with pitch, which he poured over it both within and without. It is of great interest, as showing the local coloring of the legend and the survival of an ancient custom, to observe that this practice of paying the native boats of the Euphrates with pitch has persisted in Mesopotamia down to the present day, natural pitch being used, which occurs at various localities in the valley, but particularly near the town of Hit. Sitnapistim's method of procedure, both in building and paying his boat, may still be witnessed at Hit as a matter of almost every-day occurrence.

Sitnapistim having provisioned the vessel, and brought into it all his goods and chattels, received an intimation of the immediate approach of the catastrophe; he went on board with his family and friends, closed the roof, and prudently intrusted the helm to the sailor—Buzar-sadi-rabi. Heavy rain fell during an anxious night, and as soon as daybreak appeared—

"There arose from the foundation of heaven, a dark cloud,
The storm-god Ramân thundered in its midst and
Nebo and Merodach went in front.
As leaders they passed over mountain and plain.
Ninîb went therein, and the storm behind him followed.
The Anunnaki raised high their torches,
With their radiant brightness the land glittered,
The turmoil of Ramân reached to heaven,
All that was light was turned to darkness.
. . . . . .
In the earth men perished. . . .
Brother beheld not his brother, men knew not one another. In the heaven
The gods were terrified by the deluge, and
Hastened to ascend to the heaven of Anu.
The gods were like a dog—sat down cowering on the ring wall of heaven.
Ishtar cried like one filled with anger.
Cried the mistress of the gods—the sweet-voiced—
'The former generation is turned to clay. . . .
What I have borne, where is it?
Like fish spawn it fills the sea.'"

For six days the flood lasted and ceased on the seventh, and then Sitnapistim is made to say:

"I looked on the sea and called aloud,
But the whole of mankind was turned to clay.
I opened the air-hole, and the light fell on my face:
I bowed low, sat down, and wept,
Over my face flowed my tears."

Sitnapistim then beheld the land, Mount Nizir, on which the ship grounded. It remained swinging there for seven days; on the seventh day Sitnapistim sent out a dove, which returned, then a swallow, which flew to and fro, but also returned, and finally a raven: "The raven went, saw the going down of the waters, came croaking nearer, but did not come back." Sitnapistim then left the ship with his people, built an altar on the summit of the mountain, and offered sacrifice. The poem then runs:

"The gods smelt the savor, the gods smelt the sweet savor,
The gods gathered like flies over the sacrificer.
The mistress of the gods, Ishtar, lifted up the (bow?) which Anu had made according to her wish."

A discussion then takes place among the gods, who all through are very human, and in its course Ea suggests to Bel, who seems to have been the prime mover in all the mischief, that he should for the future destroy mankind in a less undiscriminating manner—by wild beasts, pestilence, and famine. The scene ends happily with the apotheosis of Sitnapistim and his wife.

The surprising resemblance of the story to the biblical narrative, extending into identity of words, as in the case of the "gods smelt the sweet savor," points to direct derivation or borrowing, and there can be very little doubt in deciding on which side the borrowing lay. The biblical narrative is indeed a Jahvistic or monotheistic edition of the Chaldean. To this conclusion the most distinguished Assyrian scholars have been led. I need only mention here Prof. Sayce, whose opinion is expressed on page 119 of his work on The Higher Criticism and the Monuments, published by the Society for Promoting Christian Knowledge, during the current year.

The Chaldean story certainly reduces the flood to much smaller dimensions, and so far brings it nearer the range of probability; the rain lasted only seven days, and the waters have subsided sufficiently at the end of a fortnight for Sitnapistim to land. They do not cover all the high mountains, and the stranding of the ship on Mount Nizir when the flood was at its climax gives us a maximum height, which it can not have exceeded; for if this mountain had been deeply submerged, it could not have arrested the passage of the ship. The height of the Nizir mountains is about one thousand feet above the sea level, which still leaves room for a very respectable flood.

The skepticism which prevailed in the middle of this century with regard to legends seems to have given place to an almost equally great credulity. The older argument seemed to be that the presence of some obviously unveracious statements in a legend condemned the rest, want of faith in some was want of faith in

all; while the more modern view would appear to be that since so many discredited legends have been found to enshrine some important truth, all are to be assumed trustworthy till they are proved otherwise.

It may be in this spirit that Suess has elaborately discussed the Chaldean legend as though it presented us with a trustworthy account of the Mesopotamian deluge.

Reasoning from the facts as it records them, Suess lays great stress on the course taken by the ship from Surippak, supposed to have been situated near the mouth of the Euphrates, to the land of Nizir, a distance of about two hundred and forty miles up stream. Had the flood been produced solely by heavy rainfall and a consequent overflowing of the swollen rivers, the ship instead of being carried inland would have been drifted out to sea—i. e., southward into the Persian Gulf. Suess therefore suggests that a great wave was produced in the Persian Gulf, partly by a cyclone and partly by an earthquake. This wave of twofold origin then rolled in upon the low-lying land of Mesopotamia, and drove its floods of water up the valley till they washed the foot of the Nizir hills.

Of all catastrophes none are more terrible, none more disastrous than those thus produced. When the shock of an earthquake occurs beneath the sea, and affects the adjacent land, a trembling of the ground is first felt, then the sea retires and leaves the beach bare, only to return in a long, mighty wave which breaks with violence on the shore. Thus on October 28, 1746, Callao in Peru, after being shaken by an earthquake, was overwhelmed by a sea wave and utterly destroyed; of its five thousand inhabitants only two hundred survived the flood. Still more destructive was the famous earthquake of Lisbon, November 1, 1755, when the inhabitants, without a warning, were destroyed in the falling city, and in six minutes sixty thousand persons perished. The sea in this case, as in others, retired first, and then rose fifty feet or more above its usual level, swamping the boats in the harbor; at Cadiz the wave is said to have reached a height of sixty feet, and it was felt over the greater part of the North Atlantic Ocean, arriving even on our own shores, as at Kinsale in Ireland, where it rushed into the harbor and poured into the market place.

That a great sea wave so produced might have thus arisen in the Persian Gulf is quite within the bounds of possibility, particularly as a zone of the earth's crust, very liable to earthquakes, stretches across the mouth of the gulf near the Ormus Mountains.

But if we are to follow the legend, we must follow it faithfully, and as a result of the most recent investigations it turns out that all the passages which were supposed to refer to an

earthquake have been mistranslated. The earthquake is thus put out of court, and we are left with what help we can get from the hurricane, a kind of disturbance which often vies with the earthquake in the destructive nature of the sea waves to which it gives rise.

The Andaman Islands of the East Indies are a center which give birth to some of the most terrific hurricanes in the world. Traveling more or less westward and northward, these whirlwinds sweep over the waters of the Bay of Bengal and raise the sea into waves mountains high, which every now and again rush over the low-lying lands of the Ganges delta, overwhelming the unfortunate inhabitants by myriads. Thus on the night of October 14, 1737, one of these waves, estimated at forty feet in height, suddenly overtook the dwellers by the Ganges and destroyed them to the number of one hundred thousand, or, as some say, three hundred thousand souls. These storms do not, as a rule, travel toward the Persian Gulf, and the North Arabian Sea is singularly free from them; but Suess, tracing the course of the storm of October 24, 1842, suggests that for once, in the case of the deluge, an East Indian storm may have lost its way and blundered, as it were, into the Persian Gulf. The track of this storm of 1842 was as follows: At five o'clock on October 24th it reached Pondicherry; it then slightly altered its direction and veered more to the southwest, and on the 25th at midday it crossed the western Ghats, and then divided into two parts; the south center need not concern us. The northern center traveled northeastward toward the Persian Gulf, and was felt from the Gulf of Aden to Cape Guardafui, wrecking in this tract a number of vessels.

The greatest estimated height of storm waves is from forty to forty-five feet, and, as Suess points out, it must have needed a much greater wave than this to drown out all Mesopotamia up to the Nizir hills. How much greater, is a question we are fortunately able to answer positively, thanks to the accurate measurements made by the engineer Czernik during a survey for a projected railway. The Tigris rises very slowly from its mouth inland, but at Bagdad it is already one hundred and fifty-four feet above the sea level, and at Mansurijah, the lowest point where its tributary Diala Tschai emerges from the Hamrin Mountains, the height is given as two hundred and eighty-five feet; but the land of Nizir lies even still more to the north than this, and the Lower Zab, which cuts through it, can not have a less elevation than six hundred or seven hundred feet. No storm wave of which we have any record, no recorded earthquake wave, nor any combination of the two, approaches even remotely the height that would be required to carry the sea even to Bagdad; while as for the Nizir Mountains, the Valiant Pherson, who "nearly spoilt the

flood," might have drank up all the sea water which came there without any assistance from Glenlivat. If we admit that the Tigris valley was ever submerged up to this point and restored to its original condition in the course of fourteen days, we are confronted with a catastrophe not only stupendous in degree, but of a nature beyond our present powers of explanation.

But are we compelled to admit anything of the sort, and would it not be well before doing so to inquire a little more closely into the credentials and character of the Chaldean story? We have seen that the tablets on which it occurs were found in King Assurbanipal's library, and it is fairly certain that they were copied from others much older preserved in the ancient city of Erech, the city of books. It is indeed probable that the tablets in Erech may date from the time of King Khammarubi, or from about 2350 B. C. The tablets present themselves therefore with good recommendations, and we proceed to the character of the story itself. It does not occur alone, but as one chapter out of twelve in a long poem of about three thousand lines, concerning the adventures of a mythical hero named Izdubar or Gizdubar, perhaps the same as Nimrod, that "mighty hunter before the Lord" of biblical story, and plainly the prototype of the Greek Hercules.

The first tablet, containing the first chapter, is incomplete. So far as can be made out, it sets forth the misfortunes of the city of Erech, probably under the oppression of its Elamite enemies, who were so terrible in battle that poor Ishtar, its protecting goddess, "could not lift up her head against the foe."

The second and third introduce Gizdubar, already famous as a hunter, as the hero, who was looked for to deliver the city. His rivals induce Ururu, the mother of the gods, to fashion a strange being, Eabani, half man and half bull, to fight with Gizdubar. This monster comes to Erech, bringing with him a powerful lion, desert-bred, to fight Gizdubar; but the hero succeeds in slaying the lion, and so wins the friendship and esteem of Eabani. In the fourth and fifth tablets the friends encounter and overcome the terrible tyrant Humbaba, whose voice was as "the roaring of the storm, his mouth wickedness, and his breath poison." The sixth tablet, which is well preserved, tells how the hero was beloved of Ishtar. "Be my husband," she says, "and I will be thy wife. I will make thee to ride in a chariot of gold and precious stones, with golden wheels and diamond horns. When thou enterest our house under the pleasant fragrance of the cedar, men shall kiss thy feet. Kings, princes, and lords shall bow down before thee, and bring tribute." Gizdubar, however, is not to be seduced; he repels the advances of the goddess, who then presents herself as a naturally angry woman before her father Anu, and persuades him to frame a divine bull which is to destroy Gizdu-

bar. He and Eabani together slay this bull, however, and the goddess, now terribly incensed, pronounces a terrible curse upon Gizdubar. The seventh tablet is unfortunately missing. The eighth, ninth, and tenth narrate how Gizdubar, suffering under the divine anger, loses his friend Eabani and is smitten with a grievous illness. He journeys to the river's mouth to consult his divine ancestor Sitnapistim. On his way he crosses a desert where "scorpion men" guard the dark path to the "waters of the dead," which separate him from his quest. On the shore of this sea he finds a park of the gods, with wonderful trees bearing precious stones for fruit. After waiting here a long time a ferryman takes him over to the fields of the blessed, where he meets Sitnapistim. He tells his sorrowful tale, and the heart of Sitnapistim is filled with pity; but, alas! neither gods nor men can give him help. In the eleventh tablet Gizdubar inquires of Sitnapistim how he became immortal, and receives in answer the story of the deluge. After its recital Sitnapistim heals Gizdubar of his disease, and gives him the plant of life, its name being "Altho'-a-graybeard-the-man-becomes-young-again." Unfortunately, an evil demon robs him of this on the way home. In the twelfth and last tablet Gizdubar returns to Erech and utters a lament over his lost friend Eabani, whose ghost subsequently appears and recounts the doings of the dead in Hades.

Thus the deluge story is a myth within a myth, containing statements plainly unveracious; and how we are to distinguish in this mass of fiction the true from the false passes the wit of man to conceive. If we say of the deluge part of it that it is a gross exaggeration, the judgment will sound mild, but this is all that is requisite to reduce the catastrophe to commonplace proportions.

Whether Gizdubar ever existed in the flesh or not has been doubted; it is certainly remarkable that each of the chapters of the poem corresponds to one of the signs of the zodiac, and they are arranged in the same order as the signs of the zodiac. A fanciful correspondence is thus drawn between the succession of events in the life of Gizdubar and the yearly course of the sun through the heavens, and it has consequently been maintained that Gizdubar is no other than the sun himself personified. The stages in the life of man find, however, so ready an analogy in the course of the sun, that this conclusion is by no means forced upon us, and we may turn to another identification of more significance in our inquiry. It is that of the Greek story of Heracles with the legend of Gizdubar. Heracles himself is no other than a Greek Gizdubar, the Chaldean Eabani corresponds to the centaur Cheiron, the tyrant Humbaba to the tyrant Geryon, the divine bull to the bull of Crete, the park of the gods to the garden

of the Hesperides, the lion slain by Gizdubar to the lion of Nemea which Hercules slew, and finally, just as Gizdubar is ferried across the waters of the dead, so Hercules is taken by Helios in the golden boat of the sun across the ocean.

As the Greeks have borrowed so much of the legend it would be surprising if they had not taken the rest, including the story of the deluge, and accordingly we find the Greeks provided with a legend of the flood, or with more than one, as they appear to have had more than one Heracles; but that which most closely accords with the Chaldean is the flood of Deukalion.

On the other hand, the Egyptians, who had sun stories of their own, did not borrow the legend of Gizdubar, and are silent as to a deluge; a fact of extreme importance when we consider that the Egyptian civilization was contemporaneous with the Chaldean, if not indeed older. The Nile is gentler in its overflowing than the Tigris, so that Egypt did not suffer under the scourge of unexpected floods.

If, finally, we turn to China, also possessed of very ancient historic records, and liable to the destructive deluges of the Yellow River, which have earned for it the designation "The Curse of China," we discover a deluge story of great importance, to which Suess has already called attention. In the third Schû of the Canon of Yao, a monarch who reigned, it is supposed, somewhere about 2357 B. C., and therefore contemporaneous with Khammurabi, we read: The Tî said, "Prince of the Four Mountains, destructive in their overflowings are the waters of the flood. In their wide extension they inclose the mountains and cover the great heights, threatening the heaven with their floods, so that the lower people is unruly and murmur. Where is a capable man whom I can employ this evil to overcome?" Khwan was engaged, but for nine years he labored in vain; a fresh engineer, named Yû, was therefore called in; within eight years he completed great works: he thinned the woods, regulated the streams, dammed them, and opened their mouths, provided the people with food, and acted as a great benefactor to the state.

It is refreshing thus to pass from the ornate deceptions of legend to the sober truth of history; and if the facts on which the Gizdubar legend of the deluge is founded could be expressed in the same simple language, we should probably find it narrating similar events, or events as little calculated to surprise us as those of the straightforward Chinese Schû.

History then fails to furnish evidence of any phenomenon which can be called catastrophic in the geologic sense of the word, and geology has no need to return to the catastrophism of its youth; in becoming evolutional it does not cease to remain essentially uniformitarian.

And the careful foster-mother? She too, as it appears to me, has widened her studies, and must, I should think, recognize with pride the stalwart growth of her early friend. May they be drawn nearer together, and feel the warm glow which is produced by the sympathy of a common love for truth!

SKETCH OF ZADOC THOMPSON.

THE slopes and intervales of the Green Mountains have ever been a home of sterling worth. Much of it has lain modestly hidden unless some compelling occasion called it forth, as the Revolution brought out Ethan Allen and Stark of Bennington. This region has had its workers in science, who, with more generous facilities or a more assertive spirit, could have equaled in prominence many whom the world calls famous. The subject of the present sketch is an example, for he became known in his lifetime only so far as the patient performance of valuable labors of necessity brought him into notice.

ZADOC THOMPSON was born in Bridgewater, Windsor County, Vt., May 23, 1796. He was the second son of Barnabas Thompson, whose father was one of the early settlers in that part of the country.

His early life was a continual struggle with poverty. Having from childhood a passion for writing and publishing books, he earned part of the expenses of his education in this way. His first publications were almanacs, which he sold traveling about the State on foot. Thompson's Almanack became as famous in Vermont as Robert B. Thomas's in Massachusetts, and shared the honors with the latter publication in adjoining States. Its success was to a large extent due, it is said by those who should know, to a chance remark—it can hardly be called a prediction—which came one day when a clerk, who was at work upon the almanac, found that no weather forecast had been given for July. Prof. Thompson was at the time much absorbed in some investigations, and, when interrupted by the printer's inquiry as to the July weather, hastily replied, "Say, Snow about this time." The printer took him at his word and printed snow as a part of the probable weather for July. Contrary to all expectations or precedent, in July of that year there was in Vermont a fall of snow! This apparently remarkable knowledge of the probabilities of the weather made Prof. Thompson famous as a weather prophet, and greatly increased the sale of his almanacs. It should be added that Prof. Thompson made constant use of such meteorological instruments as he could obtain, and that he was one of the first in his State to study the weather in a careful and scientific manner.

Mr. Thompson was graduated from the University of Vermont in 1823, at the advanced age of twenty-seven years, and immediately turned his attention to making known the natural and civil features and history of his native State to its own inhabitants and to the world beyond its borders, which was the chief occupation of his life. Within a year his first publication in this field, a Gazetteer of Vermont, appeared at Montpelier. His first bound volume was an arithmetic, published in 1826, which had a general sale through the State. While serving as principal of an academy in Canada, he issued a geography and map of Canada for schools, which passed through several editions.

In 1832 Mr. Thompson edited and was the chief contributor to the Green Mountain Repository, a monthly magazine published for about a year at Burlington. In the following year appeared his History of Vermont from its earliest settlement to the close of the year 1832.

Taking up the study of theology and supporting himself in part by teaching in the Vermont Episcopal Institute and elsewhere, he was prepared for orders, and became a deacon in the Protestant Episcopal Church in 1836. He preached from time to time in various parishes of northern Vermont and New York, and usually supplied the pulpit of St. Paul's Church, Burlington, during the illness or absence of the rector. His health not being good enough to allow of his undertaking the labors of a parish, and being a man of "deep and unconquerable modesty of spirit," he never advanced to the priesthood.

His earlier works aroused in him a desire to issue something larger and fuller in the same line, and for many years he industriously collected from various "oldest inhabitants" and scattered records facts relating to the history, geography, and natural resources of Vermont. From 1838 to 1842 he devoted most of his time to putting together these materials and publishing the resulting Natural, Civil, and Statistical History of Vermont. His attainments in natural history were at that time limited, and he obtained considerable assistance in preparing the accounts of the plants and several classes of animals for this book from other New England naturalists. Having made the mammalia quite a specialty, he described these himself.

The undertaking was most thoroughly and conscientiously carried out, and by the time the book was ready for the press all his savings had been expended. At this juncture the Burlington publisher, Mr. Chauncey Goodrich, who was a neighbor and friend of Mr. Thompson, offered to get out the book for him at the usual prices for the labor and materials without any contingent share in the profits, and to wait for payment from the sales of the work. This generous offer was promptly accepted, and the volume, con-

sisting of six hundred and fifty-six closely printed octavo pages, was duly issued. There were three parts to the work, each of which, if printed less compactly, would have made a fair-sized volume. The first was devoted to the natural features and productions of the State; the second was the civil history; and the third was Mr. Thompson's Gazetteer, revised and enlarged. When Mr. Goodrich several times urged him to issue it in three volumes at six dollars instead of one volume at two dollars and fifty cents, and thereby get twice as much profit from each copy, he steadily declined. Having felt the inconvenience of limited means himself, his sympathies were with those in the same position, and he did not deem it right that those who could not afford the higher price should be deprived of a benefit that their richer neighbors enjoyed, even though the lower price would give him but scant return for the labor, time, and money he had expended. On its appearance the General Assembly of Vermont, regarding the work as a benefit to the State, subscribed for a hundred copies and voted five hundred dollars to the author. By this means and the proceeds of other sales he was enabled to cancel his debt to his publisher in little more than a year.

At about this time Mr. Thompson issued a text-book on the Geology and Geography of Vermont, in which his power of clear and concise statement is well exemplified. He found time also to prepare annual astronomical calculations for the Messrs. Waltons, of Montpelier. In 1845 he issued a pamphlet Guide to Lake George and Lake Champlain, with a map and other illustrations.

A State Geological Survey having been authorized by the General Assembly, the Governor in 1845 appointed Prof. Charles B. Adams State Geologist. Prof. Adams chose Mr. Thompson and the Rev. S. R. Hall as his assistants. In one season these two men explored together one hundred and ten townships. The analyses required by the survey were made at New Haven by Denison Olmsted, Jr., until his death in 1846, afterward by Thomas Sterry Hunt. The survey came to an untimely end by the refusal of the General Assembly of 1847–'48 to make an appropriation for preparing its final report. The notes, specimens, and other materials gathered were allowed to lie in boxes at Burlington and Montpelier for about a year. Then, having had a partial sense of the value of these materials impressed upon it, the General Assembly authorized the Governor to appoint some suitable person to get them together and deposit them in the State House. Governor Coolidge appointed Prof. Thompson, and the latter reported the execution of his commission in October, 1849. Many of the field notes were in a peculiarly abbreviated shorthand used by Prof. Adams, and, on his death in 1853, became almost wholly useless.

In 1847 Governor Eaton had appointed Prof. Thompson to

carry out a resolution of the General Assembly in regard to international literary and scientific exchanges. He wrote a report of proceedings and instructions, presenting the advantages of the exchange system so clearly as to reflect great credit upon himself and upon his State.

From an address which he delivered in Boston, in 1850, on the invitation of the Boston Society of Natural History, we learn something of the difficulties under which his knowledge of natural science was obtained. "What I have accomplished in the business of natural history," he said, "I have done without any associates engaged in like pursuits, without having any access to collections of specimens, and almost without books." In this address, while showing the difficulties, he at the same time insisted upon the importance of the cultivation of natural history in country places. A habit of observation and comparison of objects, he said, could be acquired quite as readily in the country as in the city. He urged that the study of natural history should be introduced more generally into our colleges and common schools, for the reason that such a study "would refine and improve the moral sensibilities of our people, and sharpen and invigorate their intellectual powers." Prof. Thompson's love for natural history was inborn, and throughout his life amounted to absolute devotion. It was the supreme force in his life. From early childhood until the end, his diligent study of Nature and zeal in collecting facts, and objects to illustrate them, never faltered. He was not only a student of Nature but her ardent and most constant lover. He also enjoyed mathematical studies and was fond of statistics, and these qualities rendered his work in all departments of science more accurate and orderly than it might otherwise have been.

Certain of his friends (his modest worth had made him many of these), knowing his great desire to see the Exhibition of 1851 at London, furnished him the means of making the trip. After an absence of three months, during which he had spent some time in Paris, he returned to his home in Burlington much benefited in spirit and in health. Yielding to repeated solicitation, he published soon after his Journal of a Trip to London, Paris, and the Great Exhibition in 1851, which gave a most realizing impression of what he had seen to those who had not made the trip.

In the ten years following the publication of his History of Vermont, railroads and telegraphs were introduced into the State, and various discoveries in its natural history were made, all of which furnished him material for a valuable supplement of sixty-four pages, issued early in 1853. The General Assembly of this year discovered what a blunder had been made in strangling the geological survey, and passed a bill appointing Prof. Thompson State Naturalist, "to enter upon a thorough prosecution and comple-

tion of the geological survey of the State, embracing therein a full and scientific examination and description of its rocks, soils, metals, and minerals; make careful and complete assays and analyses of the same, and prepare the results of his labors for publication under the three following titles, to wit: first, Physical Geography, Scientific Geology and Mineralogy; second, Economical Geology, embracing Botany and Agriculture; third, General Zoölogy of the State." At first he planned to do no more than collate and arrange such material as had been accumulated by his predecessors; but he soon found this very unsatisfactory, and, abandoning this plan, he undertook to go over the whole ground anew. He had for years been unknowingly preparing for just this task, and he threw himself into it with his accustomed energy and devotion, and suspended all other work; but ere long his overtaxed strength gave way, and his last illness was upon him. At first he could not be willing to lay aside a task so congenial, and which he so greatly desired to finish; but soon his naturally quiet and trustful disposition overcame all discontent, and in full acquiescence in the will of the God in whom he had always trusted and whom he had tried to serve, he came to the end in peace, on January 19, 1856. At this time he also held the professorship of Natural History in the University of Vermont, to which he had been appointed in 1852.

His friend for over a score of years, Dr. Thomas M. Brewer, editor of the Boston Atlas, and himself a naturalist of no small ability, thus referred to Prof. Thompson's death: "His loss, both as a citizen and a public man—he has not left his superior in science behind him in his own State—is one of no ordinary character. We have known him long and well; and in speaking of such a loss we know not which most to sympathize with, the family from whom has been taken the upright, devoted, and kind-hearted head, or that larger family of science who have lost an honored and most valuable member. Modest and unassuming, diligent and indefatigable in his scientific pursuits, attentive to all, whether about him or at a distance, and whether friends or strangers, no man will be more missed, not merely in his immediate circle of family and friends, but in that larger sphere of the lovers of natural science, than Zadoc Thompson."

When his death was announced to the Boston Society of Natural History, of which he was a member, Prof. William B. Rogers took occasion to express the high respect in which he had held him as a thorough and persevering worker in geology, saying that he possessed a larger amount of accurate practical knowledge than would have been supposed from his modest and retiring manners, and exhibited a great natural sagacity in those departments of science which he loved.

No account of the life and labors of Prof. Thompson is at all complete without some mention of his wife, for without her aid and sympathy he never could have accomplished what he did. In childhood they roamed the fields together in search of interesting objects, and later, as husband and wife, they pursued with increased enthusiasm the same study of Nature; and long after Mr. Thompson's death his wife continued her observations of animals and plants. Moreover, being a very shrewd and efficient manager in all household matters, she was able to carry the family through financial difficulties which otherwise would have frustrated many of her husband's scientific undertakings. Their home was not only a home, but it was also a museum and a laboratory. It was a very modest little white cottage, surrounded by a profusion of flowers when the season permitted, and inside, every available shelf or stand was crowded with specimens which either had been or were to be carefully studied, while not seldom there were in or about the house pens, cages, or tubs in which were kept many living animals, whose daily life was under closest scrutiny. Mrs. Thompson not only tolerated these inroads upon her housekeeping, but delighted to assist her husband in his work, and really deserves to be considered a colleague in many of his labors.

Personally, Prof. Thompson was tall, angular, of a very quiet and sedate yet very pleasant manner, a man of most amiable and sweet temper, loved by all who knew him, and respected for his sound sense and accurate judgment. Though retiring by nature, he was fond of long chats around the winter hearth with such neighbors as were congenial. Prof. Joseph Torrey was his most intimate friend, being an excellent botanist, and with him Mr. Thompson's intercourse was most delightful. He was simple, almost childlike in his tastes. Naturally somewhat conservative, his training in science had given him an open mind to all new truth. It is not improbable that the sober manner which he usually maintained came from the shadow of death which had long rested upon him. He was affected by organic disease of the heart, which finally ended his life, and for many years, knowing the possibility of sudden death, he did not trust himself far from home alone. Most often his companion was a Mr. Hills, who was draughtsman and engraver of nearly if not quite all the cuts used in his publications.

The museum in the Vermont State House contains about three thousand specimens collected by Prof. Thompson. He was one of the most reliable correspondents of the Smithsonian Institution, and corresponded also with many of the leading naturalists both at home and abroad. His achievements won him a medal from the French Exposition of 1855.

EDITOR'S TABLE.

THE NATURE OF POLITICAL AUTHORITY.

PROF. R. T. ELY, in an article entitled Fundamental Beliefs in my Social Philosophy, contributed to the October Forum, raises the question, "What is the source and sanction of the authority of the state?" "Is the state," he goes on to ask, "a mere aggregate of individuals accomplishing their purpose simply by brute force? Does might make right? If it does, then is not the question between anarchy and its opponents simply a question of superior force? But if might does not make right, what does make right? Has the state an ethical nature? If the state is itself nonethical, can the power which it exercises have an ethical element? But if it is devoid of an ethical element, can it rest upon anything less than mere brute force?" This is rather a long string of questions, and the professor tells us that he will not attempt to answer them; but he observes that if the state is a divine institution and derives its authority from God, "then we have a ground of opposition to anarchy." Otherwise—he evidently means us to infer—our ground is very weak.

It seems to us that this is a good example of the confusing of a comparatively simple matter by the introduction of what Auguste Comte would have called "metaphysical" considerations. Let us take the several questions as they come. "Is the state a mere aggregate of individuals accomplishing their purpose simply by brute force?" Answer: No, the state is an aggregate of individuals whose views in regard to what is a desirable constitution of society are in the main harmonious, and who have no occasion to use brute force except upon a certain limited number of stupid offenders against laws which, in their general operation, make for the good of the community as a whole. "Does might make right?" Answer: No, might does not make right, but it is an excellent thing for giving effect to what the upholders of social order believe to be right. "If it does, then is not the question between anarchy and its opponents simply a question of superior force?" Answer: No, for if might *makes* right (which is the hypothesis), then right as well as might is on the side of the state. "But if might does not make right, what does make right?" Answer: The only way to "make right" is to do right actions. Right is something that can never be more than approximately attained; but we hold that social order is right because it secures, or at least makes possible, the happiness of the great majority of human beings, and deprives none of happiness save those whose happiness involves unhappiness to others. "Has the state an ethical nature?" We wonder whether Prof. Ely stopped to consider just what he meant by this question. "The state" has no character apart from the individuals who represent and carry on its action. If it be asked whether these persons, the legislature, the executive, the judiciary, have ethical aims in view, we may answer that in general they have—that is to say, they make, administer, and interpret laws with a general view to the good of the community and to principles of equity between the individual members thereof. So far as this underlying intention is present, the action of the state is ethical; so far as it is absent, is it nonethical. The obligation to be governed by such an intention is one that rests upon each person having public functions to perform *individually*. He either feels or does not feel individually a sense of duty in con-

nection with his official acts: so far as he does, he helps to make the action of the state ethical; so far as he does not, he deprives it of an ethical character. To lay down the principle that "the state," abstractly considered, "has an ethical nature," is vain for any practical purpose, seeing that the question at once arises, How is that ethical nature to find expression except in the action of individuals, and if these do not carry a sense of duty, or their own "ethical nature," into their public acts, what are you going to do about it?

We suspect, however, that Prof. Ely, in asking this question, really means to ask whether the state has a warrant for undertaking various policies for the simple purpose of "doing good," as the phrase is. If we grant that the state has an ethical nature, he will doubtless infer and ask us to infer that the state should be a knight-errant for the correction of all evils and abuses. From that point of view our answer is: The state is no more and no less ethical than the persons who guide its action, and any ethical nature which it possesses simply represents on a very small scale the ethical nature of the community at large. All this talk about the state and what it could or should do diverts attention from the much more important question of calling into activity the ethical nature of individual citizens. If each citizen can only be persuaded to make himself an ethical element in the fullest sense, the task of government will become much lighter, and many of our social difficulties will completely disappear. On the other hand, if the Government is going to do the ethical business for the people, the outlook is not at all satisfactory: Government will be overburdened, and the ethical nature of the community will not be developed as it otherwise might be; in fact, it will run great risk of suffering partial atrophy.

Finally, we are told that if the state is a divine institution, and its authority comes from God, then we have a good answer to the anarchist; if not, not. The latter is not distinctly stated, but it is distinctly implied. Our answer to this is that "the state" is a divine institution, and derives its authority from God just as much as and no more than the New York Central Railway or any other corporation down to a village baseball club. It may be under righteous or unrighteous control, so may the railway, so may the baseball club. When it enacts dishonest and oppressive tariff laws, it is just as well not to lay too much stress on its divine mandate. On the other hand, when it enacts an honest law for the good of all; when it faithfully carries out its obligations, national or international; when it upholds justice between man and man, we set the seal of our moral approval on its action, but we do not ascribe any special authority to that action on the ground that "the state is a divine institution." We feel instinctively that nothing can be more divine than justice, and when the state succeeds in being just, we simply rejoice that it has been able to approximate to our conception of the divine. The state, in fact, does not, so far as this goes, differ in any respect from the humblest individual citizen who has it in his power to do right or wrong, to place himself in harmony with or in opposition to what he feels to be the will of God.

As to our answer to the anarchist, we need not be so particularly anxious about that. Unless we honestly believe we are in the right in wishing to preserve the existing frame of society, we had better give in to the anarchist and take counsel with him as to how we may remold things "nearer to the heart's desire." If we think we are in the right, we have simply to maintain our position and use what dissuasives we can on the anarchist fraternity. We should certainly be prepared to listen to any arguments they may bring forward that are not of the dynamite order.

Society, we may safely admit, is not perfect; and if the anarchist can point out possible improvements, then he is a helper from whom we should not turn away. But metaphysical views of the nature of state can give no help in any practical problem.

BEING convinced by the course of recent events that the public needs professional guides in social affairs, the Society for Education Extension, of Hartford, Conn., has projected a School of Sociology, to be opened in the present autumn. Chester D. Hartranft, D. D., is to be its president, and among the lecturers already secured are Professors John Bascom, Austin Abbott, Otis T. Mason, William Libbey, Jr., William M. Sloane, and William O. Atwater. We have long maintained that definite laws underlie the phenomena of human society, or, in other words, that a science of sociology is possible. We should be glad to see a good institution for research and instruction in this field established, and hope that the undertaking of the Hartford society will meet with all deserved success.

LITERARY NOTICES.

SYSTEMATIC SCIENCE TEACHING. By EDWARD GARDNIER HOWE. International Education Series, No. 27. New York: D. Appleton & Co., 1894. Pp. 326. Price, $1.50.

THIS is a book the value of which to the educator, both parent and teacher, it would be difficult to overestimate. To the advanced instructors of to-day the value of science teaching is no longer in question. The book is full of suggestion, and shows the line of investigation adapted to each province of Nature.

Dr. Harris well says, in his preface, that the pupil must get not only the dead results but also the living method — the method of observation and discovery; that the powers of observation are strengthened chiefly by learning to think about what one sees; that seeing only fails to produce that cultivation of observation that the capacity for scientific observation produces—the act of recognizing, not the mere seeing, giving scientific knowledge. He goes on to say: "Science leads to invention, and invention leads to the demand for a scientifically educated class of laborers. Education emancipates the laborer from the deadening effects of repetition and habit, the monotony of mere mechanical toil, and opens to him a vista of new inventions and more useful combinations." The necessity is suggested for the introduction of the results and methods of science into the elementary schools as early as possible, in view of their influence upon civilization.

Mr. Howe's work is very carefully graded, and he insures the constant interest of the pupil by a happy selection of objects from Nature. The most valuable feature, however, of this work is the detailed hints and directions to the teacher and pupil, that will secure correct and accurate habits of scientific observation.

The results of this systematic teaching of science have been exceedingly satisfactory. Interest has rarely flagged, and the senses have been developed to a surprising degree; the hand has been trained in the art of experiment, and the mental powers have made a steady and healthy growth. An exactness and freedom of expression have been attained which is the truest index of a mind full of observed facts and trained to the thoughtful consideration of matters presented. The advanced pupil has gone to the study of books with ease and profit, but the work has reached deeper and further; the inborn love of childhood for birds, flowers, and pretty stones has quickly responded to wise encouragement and become the present source of much happiness, and this of the purest sort. Incidentally tending to keep out low pleasures, it has been in many cases the prelude to the recreations of mature life.

That with the pleasurable acquiring of much useful knowledge the sense can be quickened, the mental powers developed, and a loving interest in ever-present and pure things be fostered, which in mature life shall render us in a great degree independent of time, place, or man's device for needed recreation, is certainly all that need be said in its favor.

In encouraging the teacher to patience and advising the school board to generosity in regard to this work, Mr. Howe says, "If the children are learning 'to *think* to a conclusion,' if they are becoming *observant*, if they are *interested* in their school and go home full of the things they have seen and done, do not criticise because those 'things' are 'bugs and weeds,' nor complain because more words are not learned, or arithmetical problems solved. The 'words' may be meaningless and problems mechanical, but active, willing seeing and thinking is in the line of all that is desirable."

TENTH ANNUAL REPORT OF THE BUREAU OF ETHNOLOGY. To the Secretary of the Smithsonian Institution, 1888–'89. Pp. 822. ELEVENTH ANNUAL REPORT, 1889–'90. Pp. 553. By J. W. POWELL, Director. Washington: Government Printing Office.

THE work of this bureau is substantially continuous, so that these two noble reports may be treated as one. In this work the lines of investigation which have appeared from time to time the most useful or the most pressing have been confided to persons trained in or known to be specially adapted to their pursuit. During the period covered by these reports, the work of exploring the mounds of the eastern United States was carried on under the superintendence of Dr. Cyrus Thomas; during the latter part of the time Dr. Thomas was engaged in preparing a final report on his work. Colonel Garrick Mallery visited Maine, Nova Scotia, and New Brunswick in studying the pictographs of the Abnaki and Micmac Indians. W. J. Hoffman gave his attention to pictographs, petroglyphs, and birch-bark records in the Northwest, and to the records and ceremonies of the Midē'wiwin or Grand Medicine Society of the Ojibwas, an order of shamans professing the power to prophesy, to cure disease, and to confer success in the chase. H. W. Henshaw and Jeremiah Curtin collected vocabularies and myths on the Pacific coast, and did other linguistic work. James Mooney investigated the customs, languages, etc., of the Cherokees at their reservation in North Carolina, made a collection of the plants used by them in medicine, and studied their antiquities. Victor Mindeleff explored ruins and collected potteries in Arizona. The Rev. J. Owen Dorsey prepared many papers embodying the results of previous studies. A. S. Gatschett completed his Klamath Grammar, and embodied in literary form the fruits of his other investigations among the Klamath Indians. The illustrations for the publications of the bureau were edited by W. H. Holmes, who was also active in his studies of aboriginal archæology. The publications of the bureau for the two years include the Bibliographies of the Iroquoian and Muskhogean Languages, by J. C. Pilling; The Problem of the Ohio Mounds, by Cyrus Thomas; Textile Fabrics of Ancient Peru, Ancient Art of the Province of Chiriqui, Colombia, and A Study of the Textile Art and its Relation to the Development of Form and Ornament, by W. H. Holmes; Aids to the Study of the Maya Codices, and the Circular, Square, and Octagonal Earthworks of Ohio, by Cyrus Thomas; Osage Traditions, by the Rev. J. Owen Dorsey; and the Central Eskimo, by Dr. Franz Boas. The volume containing the tenth report is nearly all occupied with the elaborate work, richly illustrated, of Colonel Garrick Mallery, on the Picture Writing of the American Indians. The volume of the eleventh report contains papers on The Sia (Pueblo), by Matilda Coxe Stevenson; Ethnology of the Ungava District, by Lucien M. Turner; and A Study of Siouan Cults, by J. Owen Dorsey.

SCHOOL MANAGEMENT. By EMERSON E. WHITE, A. M., LL. D. American Book Company. Pp. 320. Price, $1.

THE subject emphasized in this volume is character training. The author considers that the proper end of school government is to prepare pupils for self-control and self-direction in life. Good order and application in study are essential conditions in attaining this result, but must not be substituted for the goal itself. From this it follows that the well-governed school depends more upon what the teacher is than what his method may be. If only one law were written above the door of every American schoolroom it ought to be, No man or woman shall enter here as teacher whose life is not a good model for the young to copy.

The elements of governing power are described as fresh knowledge, skill in in-

struction, heart-power, self-control, present-mindedness, wisdom in common things, and positive moral character. The best qualified teacher, however, may fail if his methods of instruction or discipline are brought into disrepute through official interference, or if his surroundings are cramped and unhealthful.

The mechanical means of government suggested are the proper seating of pupils, a good programme, a self-regulating system, and as few rules as possible. Under the head of moral training is embraced the education of the will, school incentives, punishment, and the principles of direct ethical instruction. Thirty-two topics in morals and manners are named and the material given for fifteen lessons in the primary grades and for sixteen in higher classes. A discussion of the function of religion in the school is given at the close. In this it is held that religious motives may be rightfully introduced in order to render moral teaching efficient.

Although the ethical value of several of the stories may be questioned, the fundamental lessons are such as are greatly needed in public schools, and in the hands of an earnest teacher the book can not fail to be a means of moral uplifting.

THE ORTHOËPIST. By ALFRED AYRES. New York: D. Appleton & Co. Pp. 292. Price, $1.

THIS is a revised edition of a little manual upon pronunciation that appeared fourteen years ago. A thousand words that are often mispronounced have been added, and among these are many foreign names which betray the unlettered. We are told to avoid saying *ŏl'wuz* for *al-wāys*, *sparrowgrass* for *as-par'a-gus*, and *be-cŏz* for *be-cause*. Educated people may pass by the ranks where these vulgarisms are enrolled and meet foreign recruits of doubtful address.

Although the author presents *chamois* as *shăm'wa* and *haricot* as *ă'rē'kō'*, he states, "It is well to make one's pronunciation when speaking English as English as permissible." From this we find that Mr. Ayres has his little linguistic leanings, since the word singled out for Anglicizing is *cicerone*, given as *sĭs-e-rōne*, while *massage*, which in the International is English *mass'-age*, appears here only as *ma-sazh'*. Chemical terms are variously marked. The author favors *quī-nīne*, and says of *iodine*, "My impression is that long *i* will ultimately prevail." *Bromide* and *chloride* are marked both short and long, from which it may be judged that Mr. Ayres is unfamiliar with the late decree of chemists making the *i* short, and even dropping the final *e* in spelling. Among English words boatswain is given as *bosn*, a colloquialism according to the International, while *bellows* and *strew* are preferred as *bĕl-lus* and *strō*. In regard to his own profession, he tells us that any pronunciation but *or'thoëpy* and *or'thoëpist* sounds inelegant to him. Unhappily, we know the Greek progenitor of the word is *ὀρθοέπεια*, and that the French with loyal grace make this *orthoëpie*. In English too we remember *or-thog'ra-phy* and *orthog'a-my* from the same root *ὀρθός*, and we can not understand why there should be a lack of elegance in accenting the word "correct" correctly according to its descent.

But probably the whole trouble is with us; we are asking that the orthoëpist should verify his decisions in a scientific manner by some rule of consistency or etymology, whereas his art is in an inchoate state, and this little book helps us to realize its struggle for development.

A SYSTEM OF LUCID SHORTHAND. Devised by WILLIAM GEORGE SPENCER. With a Prefatory Note by HERBERT SPENCER. New York: D. Appleton & Co. Pp. 30. Price, 50 cents.

THOSE who have examined his Inventional Geometry could not fail to be convinced that W. G. Spencer was a man of no small mental caliber. This conviction will be strengthened by a glance at the production before us. The system of shorthand which it embodies was devised by him in the course of a few years preceding 1833. The present exposition was drawn up by his son, Herbert Spencer, in 1843, and is now printed unchanged, except by the addition of four specimens. In his prefatory note Mr. Herbert Spencer states that he has been impelled to publish the system at this late day "from the conviction, long since formed and still unshaken, that the Lucid Shorthand ought to replace ordinary writing. Possessing, as it does, not equal legibility but greater legibility (the distinctions among the symbols being so much more marked), and hav-

ing at the same time the brevity which shorthands in general possess, the use of it for all purposes would be immensely advantageous to mankind." A letter from Herbert Spencer to his father, and one from his father to him, both written early in 1843, are reproduced in photoprint, as specimens of continuous writing by this system.

WEALTH AGAINST COMMONWEALTH. By HENRY DEMAREST LLOYD. New York: Harper & Brothers. Pp. 563. Price, $2.50.

THE larger part of this book is taken up with the detailed history of the Standard Oil Trust, the facts being cited from records of courts and from the testimony presented to congressional and State legislative committees. While Mr. Lloyd has written an arraignment, and is at no pains to conceal his hatred of this trust, he offers a mass of evidence which in volume and significance is fairly startling. Abating all that in his book is due to the heat of a prosecuting attorney, enough remains to show that aggregated wealth in this country has been and is grossly abused to the public oppression. The vast power of the Standard Oil Trust began in the dishonesty of railroad managers, who, interested in the dividends of the trust, betrayed their own employers, the stockholders in the railroads, and not only carried oil for the trust at specially low rates, but at times paid to the trust the cash taken from its rivals in the shape of exorbitant rates. Advantaged by such plunder as this, the progress of the trust to colossal wealth was rapid; competition with it became impossible; and, passing from the carriage and refining of oil to production, it is now in possession of the principal oil fields of America. With the true genius of conquest it soon discarded the railroads for pipe lines, building these with the capital placed in its coffers by the railroads themselves; and if, as the more economical mode of transportation, the pipe lines were inevitable, it is still true that their introduction was hastened by the suicidal treachery of the railroad chieftains.

It is an everyday assumption that direct pecuniary interest is an efficient check upon the wastes and frauds of servants. This assumption is contradicted in every page of the history of the Standard Oil Trust. Through supineness or through the bribery of leading representatives the stockholders of the railroads concerned have been absolutely indifferent to the wholesale and repeatedly exposed theft of their property. In two notable instances—in Columbus, Miss., and in Toledo, Ohio—the communities withstood the trust manfully and succeeded. These two cases are the only ones of importance where, by trusting each other, the members of American communities have managed to preserve industrial freedom threatened by the trust.

Mr. Lloyd has no remedy to suggest for the abuses he describes with so much passionate force. He looks only to arousing public indignation by a simple recital of the facts.

A JOURNEY IN OTHER WORLDS. By JOHN JACOB ASTOR. New York: D. Appleton & Co. Pp. 476. Price, $1.50.

THERE are always some members of a community who, like Grant Allen, prefer their science dry; but there are also others, it is impossible to judge how large this class may be, that like scientific truths flavored and put up in palatable packages. To please the latter is manifestly the purpose of this book. The aim to arouse interest in the wonders of Nature is a worthy one, and, on Jesuitical principles, it may be allowable to give hypodermic injections of science, but the *sine qua non* of all this is that pure science only should be thus installed, for if facts be diluted with flights of fancy the recipient may in the end fail to recognize what is truth and what is not.

In the romance before us we are introduced to the world in the year 2000, and to the office of a company whose business it is to straighten the axis of the earth. This it endeavors to do by shifting the superfluous weight of water from the pole nearest the sea to the one leaving it. The Arctic Ocean is alternately pumped out and replenished, the power being furnished by dynamos at Niagara and the Bay of Fundy. On the Antarctic continent the crust is thin, so energy is obtained from sunken boilers which supply superheated steam from the earth's interior.

Several friends "tired of being stuck to this cosmical speck with its monotonous

ocean, leaden sky, and single moon," attempt a journey to Jupiter in the Callisto, a cylindrical car made with double sides of glucinum. It is protected against the intense cold of space by an interlining of mineral wool and charged with *apergy*, the opposite of gravitation. It is consequently repelled from the earth's surface until attracted by Mars and Jupiter, when the charge is tempered to prevent annihilation. The average speed of the ship is three hundred and eighty miles a second.

The celestial voyage is an interesting lesson in astronomy. The travelers enjoy a near view of our moon, go within ten miles of the satellites of Mars, pass through the nucleus of a comet, approach various asteroids, and finally, in a little short of twelve days, land upon Jupiter. The state of development there corresponds to the Carboniferous age upon earth. The explorers breakfast upon mammoth, while all about them are known and unknown monsters, turtles, tortoises, and jellyfish. The flowers through contraction of their fibers sing at sunset and attract the birds; but gigantic ants thirty feet long trouble the newcomers, and after a brief survey of Jupiter they depart for Saturn. There they meet spirits who materialize and tell them of many unknown laws of Nature, explaining the process of building a body from the elements. Through the services of one of these, Ayrault visits the earth in spirit form, and concludes that he would rather resume his terrestrial shape and return to our insignificant planet. Shortly after, the Callisto leaves Saturn and the adventurers are restored to earth.

The book is well illustrated, and perchance may prove to be a bypath to science.

LAW AND THEORY IN CHEMISTRY. By DOUGLAS CARNEGIE, M. A. London and New York: Longmans, Green & Co. Pp. 222. Price, $1.50.

THIS book contains the substance of a course of lectures delivered before an audience of teachers of elementary chemistry in a summer school at Colorado Springs. Seven subjects are treated, namely: The birth of scientific chemistry, the phlogistic period, chemical classification, the atomic theory, kinds of compounds, molecular architecture, and chemical equilibrium. Obviously the volume is not a complete treatise on chemical theory or any division of it, and the author offers it as a "companion book" for students who wish "to recapitulate and coordinate the more important principles of chemistry before proceeding to more detailed and advanced works." The author has selected for attention those essential topics which are treated inadequately or not at all in current text-books, or which present especial difficulties to the student. He has aimed to show these topics in their proper perspective, and to point out the trend of modern research with respect to them.

A DICTIONARY OF ELECTRICAL WORDS, TERMS, AND PHRASES. By EDWIN J. HOUSTON, A. M., Ph. D. Third edition. New York: The W. J. Johnston Company, Limited. Pp. 667. Price, $5.

IF a special dictionary is needed for any branch of science it certainly is for electricity. Electrical matters have a side of interest for the scientist, the business man, the mechanic, and for numerous users of electrical appliances. Moreover, the phenomena of electricity are so manifold and so peculiar, and the apparatus for exhibiting or utilizing them exists in such great variety, that a large vocabulary of electrical terms has necessarily arisen. This vocabulary, furthermore, is rapidly growing with the growth of electrical science, so that it can not be mastered without competent assistance. Such assistance Prof. Houston undertook to supply in 1889, when the first edition of this dictionary was issued. He and his publishers have spared no pains to keep up with the growth of the electrical vocabulary since that time, by issuing a second and a third enlarged edition. The present edition, which follows the second after an interval of scarcely two years, has been increased by twenty per cent, the additions being inserted as an appendix. Prof. Houston's dictionary deserves the term cyclopedic, for not only are the words and phrases carefully defined, but the nature or construction of the thing defined and the electrical principles applying to it are set forth, while a great many pieces of apparatus are figured, and many processes are illustrated by diagrams. There are five hundred and eighty-two illustrations in the volume, and over six thousand words, terms, and

phrases are defined. Where there are several possible catch-words in a phrase, cross-references from the others to the one under which the phrase is defined are liberally inserted. The mechanical execution of the book is of a high grade.

THE EVOLUTION OF WOMAN. By ELIZA BURT GAMBLE. New York: G. P. Putnam's Sons. Pp. 356. Price, $1.50.

THIS work shows considerable research and careful collating of testimony, but is much stronger historically than scientifically. The title is a misnomer. Not even an attempt is made to show the evolution of woman, or of the special aptitudes with which the author endows her. When once she appears upon the scene her development is dropped and only her relationship with man is discussed. The book might be more aptly called The Rise and Fall of Woman, with a Prophecy of her Renaissance. Beginning with an account of the earliest forms of life and proceeding to sex differentiation, the author attempts to prove that the female organization is generally superior to the male throughout the organic world. Among bees, aphides, and tadpoles it has been noted that abundant nutrition, light, and moisture result in females, while unfavorable conditions give rise to males. Among plants staminate flowers open first, and "the larch bears female blossoms in its luxurious stage; but as soon as its vigor is lost, male flowers appear." In the human race, more boys are born after epidemics, wars, and famine. The masculine element is, however, not only conditioned upon starvation, but cases of reversion and abnormities are much more numerous with men, while their liability to defective sight and color-blindness indicates that the male power of vision is deteriorating. The author denies that the earlier races of men lived in promiscuity and lawlessness, and deems it more probable that, as among birds and mammals, the females were courted and held in honor. Subsequently kinship was reckoned through the mother and a system of matriarchy established. The prevalence of the gens and early supremacy of woman is attested by the feminine names given to tribes and countries as well as by customs and allusions in historic periods. The author has bestowed great care upon this part of her argument, and it furnishes a plausible explanation of wife-capture and divers obscure wedding rites.

The origin of marriage is described in no gentle terms, the existence of love being ignored. The early Grecian state is well depicted, and an excellent picture is given of Spartan and Athenian women. The change in the position of woman from her status under early Roman law to that under the Antonines, when the influence of Stoic philosophy was felt, is also well brought out. With the conclusion as well as with various assertions scattered throughout the book it is impossible to agree. Some are contrary to observed and verified facts, and one premise has neither scientific authority to support it nor any evidence furnished in its favor—i. e., that the higher faculties are transmitted through the female. It may safely be said that there is no embryologist or biologist so rash as to claim that one parent transmits certain qualities exclusively. Neither would any student of human nature affirm that passion or affection was monopolized by either sex. As to maternal love, we do not know whether or not it is "divine, uncreated," but we do know that paternal love is also a primary instinct, not only strong in mankind, but found among birds and fishes. All parental love, however, is a consequent, and it may be noticed that hyperexaltation of it often follows thwarting or lack of sexual love which is its natural antecedent.

TWELFTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY, 1890–'91. By J. W. POWELL, Director. Part I, Geology, pp. 675, with Map; Part II, Irrigation, pp. 576. Washington: Government Printing Office.

DURING the year covered by the geological report topographical work was carried on by the survey in twenty-seven States and Territories, and an area of 44,100 square miles was surveyed and mapped. Geological work went on on the two lines of the areal distribution of formations and of the study in field and office of various problems in rock structure and history. New work was instituted upon the mineral phosphates of Florida, and in co-operation of the State and national surveys in New Jersey. Pale-

ontological work was carried on on the two lines of the identification and correlation of geological formations by the organic remains contained in them, and of the study, from a biological point of view, of the faunas and floras contained in the rock for the purpose of obtaining a critical knowledge of the genera and species, and of the evolution of life and its relations to the environment during geological time. In the division of chemistry and physics a series of valuable measures of earth temperatures was obtained in a dry well four thousand five hundred feet deep at Wheeling, W. Va. Accompanying the report are papers on the Origin and Nature of Soils, by Prof. Shaler; the Lafayette Formation (or the Atlantic Coastal Plain), by W J McGee; the North American Continent during Cambrian Time, by C. D. Walcott; and the Eruptive Rocks of Electric Peak and Sepulchre Mountain, Yellowstone National Park, by J. P. Iddings.

The irrigation survey embraces two divisions of primary importance, and a third, of more immediate apparent utility, dependent upon them. First is the systematic mapping of the arid regions; the second division consists of measurements of the amount of water flowing in the most important streams and computations of the quantity available each day of the year, either for immediate irrigation or for storage purposes; and the third division consists of engineering examinations of such localities as the knowledge of the topography and of the water supply seemed to indicate as favorable for great irrigation developments. The results of the third year's work of the survey, except the topographical maps which are issued from time to time, are shown in this report, which gives a description of 147 reservoir sites surveyed and reported for segregation, with the hydrographical data, fully illustrated by diagrams. The report is accompanied by a description, by Mr. Herbert M. Wilson, of the irrigation works of India as a practical example of irrigation engineering. The total area of land segregated for the 147 reservoirs—33 in California, 46 in Colorado, 27 in Montana, 39 in New Mexico, and 2 in Nevada—is 165,932 acres, which will afford a water surface, should all the reservoirs be filled to the height designated in the segregations, of 108,350 acres, and would be capable of supplying about a million and a half acres of cultivated land. A caution is given to the effect that the oscillations of water supply from year to year are so great that measurements made in any one year must be looked upon with distrust if large interests are at stake.

RACE AND LANGUAGE. By ANDRÉ LEFÈVRE, Professor in the Anthropological School, Paris. The International Scientific Series, Volume LXXII. New York: D. Appleton & Co. Pp. 424. Price, $1.50.

WHEREVER the several races of man have spread they have carried their respective languages, so that discoveries concerning the distribution of peoples throw light upon the history of language and *vice versa*. Hence there is much advantage in considering race and language together as is done in this book. The author finds in the history of language abundant traces of evolution, starting from inarticulate cries and passing through the syllabic, agglutinative, and inflected stages to the highest stage—the analytic. Certain languages have stopped on the lower planes of development and the people who speak them are, for the most part, those who have not gone forward in civilization nor spread out from their early homes over other lands. Thus, while inflected languages, and especially the Indo-European family, have been widely diffused, the agglutinative tongues have retreated to the borders of the civilized world. Taking up each class of languages in turn, the author passes in review the monosyllabic group of the extreme East, the agglutinative idioms of Central and Southern Asia, the Malayo-Polynesian and the African languages, telling something about the peoples by whom each is employed. The literature, rudimentary in several cases, of each group is also described. Thus we learn that the genius of the Malay is less suited to moral treatises than to tales and legendary histories. The most original contribution of the people of the Sunda Islands to literature is their popular poetry, and their kinsmen, the Polynesians, share their gift of poetical improvisation. After the African a class of agglutinative languages which the author calls polysynthetic is discussed. This class includes Basque and Eskimo, Algonkin and Iroquois, Nahuatl and Ketchua.

Passing to inflected and analytic tongues, the history of the Semites and the Indo-Europeans and their several languages is sketched. The rest of the volume—seven chapters—is devoted to a more detailed survey of the Indo-European family, its roots, parts of speech, compounds, and its phonetics being separately discussed. In the closing chapter the chief events in the history of the English and French languages are noted.

PRACTICAL LESSONS IN PHYSICAL MEASUREMENT. By ALFRED EARL, M. A. London and New York: Macmillan & Co. Pp. 350. Price, $1.25 net.

BELIEVING that a training in physical measurement is the most solid basis of scientific knowledge, the author has prepared this book as a laboratory manual for an introductory course of study in science. It is devoted to simple measurements of length, mass, and time, and care has been taken to make the course logically progressive. The author hopes also that the book may serve in some degree to bridge over the space between the laboratory and other class rooms by acting as a "practical arithmetic," and to some extent as a "practical grammar." A large number of exercises on each variety of measurement are given, and the general character of the course is promising for thorough results.

In *The Care and Feeding of Children* (Appleton & Co., 50 cents) *Dr. Emmett Holt* offers a guide to mothers and nurses in the form of a catechism. The questions and answers were first prepared for the instruction of nursery maids, and pertain to the proper oversight of babies from a few days old to as many years. The directions have the merit of precision and of brevity; and, while many of the precautions are needless for healthy children, no harm can come in any case from following the rules given for infants over a year old.

As usual with books of its kind, the importance of rearing babies naturally is not sufficiently emphasized, and several suggestions tend to defeat such nurture. Patented foods are, however, rigorously condemned with reason, and this is perhaps more than might be expected, even of a doctor, in an artificial age.

The American Historical Register is a new periodical, begun with the September number, 1894, as a monthly gazette of the patriotic societies of our country, with *Charles H. Browning* as editor in chief and a number of men and women representing the patriotic societies as associate editors. It is intended to be generally historical, biographical, and genealogical in its scope, and to be a literary exchange and repository for American historical students. The first number contains an account of the work of the Association for the Preservation of Virginia Antiquities, and articles on the Hillegas family, the Daughters of Liberty; Major William Dyce, of New York; Stories of Colonial Families; General James Taylor, of Kentucky; General William Henry Harrison, Major George Croghan, and the Medal of Honor Legion. (Published at Philadelphia.)

A Laboratory Manual of Physics and Applied Electricity has been arranged and edited by Prof. *Edward L. Nichols*, from his own work and that of his associates in the department of physics in Cornell University, to supply in some measure the needs of a modern laboratory, in which the existing manuals of physics have been found inadequate. The author has thought best in it to encourage continual reference by the student to other works and to original sources rather than to provide a complete and sufficient source of information. The first volume, now before us, embraces a junior course in general physics, and has been especially prepared by Ernest Merritt and Frederick J. Rogers. It is the outgrowth of a system of junior instruction that has been gradually developed during a quarter of a century, and affords explicit directions, together with demonstrations and occasional elementary statements of principles. (Published by Macmillan & Co. Price, $3.)

The fifth *Report of the Missouri Botanical Garden*, for 1893, represents the financial condition of the trust as sound and the garden as kept in good condition. The trustees are able to carry forward a surplus of $14,649. The additions to the herbarium during the year consisted mainly of current American collections. As now arranged, the herbarium contains the Engelmann collection of 98,000 specimens of all groups; the general herbarium of higher plants, 108,000 specimens;

and the collection of thallophytes, 16,420 specimens, making in all about 222,420 specimens. It also has received considerable collections of wood wedges, thin veneers of woods mounted as transparencies, and the set, so far as issued, of Prof. Nördlinger's sections. The scientific papers published in the report comprise a study of the Venation of Willows, by Dr. N. M. Glatfelter; Material for a Monograph on the Tan Woods, by J. Christian Bay; The Sugar Maples, with a winter synopsis of all North American Maples, by Dr. Trelease; Notes on a List of Plants collected in Southeastern Missouri, by B. F. Bush; and some papers of a more special and technical character by Dr. Trelease and J. C. Whitten.

A posthumous work by M. *A. de Quatrefages*, entitled *Les Émules de Darwin* (the Rivals of Darwin), is published by Félix Alcan, Paris, in two volumes. In it the learned author, after examining the work of Darwin and his French predecessors, passes in review the conceptions of those who were his rivals—or perhaps we might better say his co-workers—in bringing the new doctrines to the attention of naturalists, or in trying to perfect the doctrine of the master. These *émules* are Alfred Russel Wallace, M. Naudin, Mr. Romanes, Carl Vogt, Felippi, Haeckel, Huxley, Owen, Mivart, Gubler and Koelliker, D'Omalius d'Halloy, and Erasmus Darwin, of whose work full reviews and as "impartial as possible" are given. From this examination the author receives but one impression—that of our impotence to resolve the great problem which so many eminent men have attacked in vain. This review is preceded by a preface by M. Edmond Perrier, in which the work of Quatrefages is summarized at length, and by a eulogy or address on his life and labors, delivered by M. E. T. Hamy at the opening of the course in anthropology of the Museum of Natural History, Paris, in May, 1892. These biographical notices occupy about half of the first volume.

The *Annual Report of the United States National Museum* for the year ending June 30, 1892, gives the number of specimens in the collections as at that time 3,223,941, showing that in ten years from what was practically the date of occupancy of the museum building the collections had increased sixteen fold. The institution is crowded for space, and will soon be compelled, unless it is relieved, to discourage rather than seek additions. It has already lost several large and important collections on this account. Besides the reports of the assistant secretary in charge, Dr. G. Brown Goode, and of the curators of the several departments, the volume contains papers on Japanese Woodcutting and Woodcut Printing, by T. Tokuno; the Relation of Biology to Geological Investigation, by Charles A. White; Scientific Taxidermy for Museums, by Dr. R. W. Shufeldt; The Shofar, by Cyrus Adler; The Crump Burial Cave, by Frank Burns; Minute Stone Implements from India, by Thomas Wilson; and Comparative Oölogy of North American Birds, by Dr. Shufeldt, with a bibliography and list of accessions.

In *A Study of Certain Figures in a Maya Codex*, Mr. *J. Walter Fewkes* takes up a peculiar figure in the Codex Cartesianus, which is known as that of the "long-nosed god," and inquires into its meaning. A relationship is traced with the rain god, and certain features in the arrangement of the figures are supposed to represent the four world-quarter symbols.

The students of Leland Stanford Junior University should have a thoroughly intelligent appreciation of the functions of law and development in Nature if they properly digest the course of lectures on *Factors in Organic Evolution* given by President *Jordan* with the assistance of some of the other professors. This we can infer from the syllabus, which comes to us as a volume of one hundred and forty-nine pages printed on one side of the paper, and gives the subheads treated in each of the fifty-eight lectures. The scope of the course may be gathered from the following subjects of some of the lectures: The Unrolling of the Universe; Heredity: the Great Conservative Force in Evolution; The Meaning of Sex; Ontogeny and Phylogeny; The Origin of the Eye; Law of Self-activity; Evolution of Plants; The Way out of Pessimism; The Fool-killer and his Mission; The Evolution of the Idea of God; and The Evolution of the Common Man. A list of books recommended for reading is added.

The eleventh volume of the *Bulletin of the United States Fish Commission* for 1891 contains papers on A Reconnaissance of the

Streams and Lakes of Western Montana and Northwestern Wyoming, by Barton W. Evermann; a report of Investigations made in Texas in 1891, by the same author; A Statistical Report on the Fisheries of the Gulf States, by J. W. Collins and Hugh M. Smith; Report on a Collection of Fishes from the Albemarle Region of North Carolina, by Hugh M. Smith; The Spawning Habits of the Shad, by S. G. Worth; A Preliminary Report on the Aquatic Invertebrate Fauna of the Yellowstone National Park, Wyoming, and the Flathead Region of Montana, by S. A. Forbes; Notes on a Collection of Fishes from the Southern Tributaries of the Cumberland River in Kentucky and Tennessee, by Philip H. Kirsch; Report on the Fisheries of the South Atlantic States, by Hugh M. Smith; Report on the European Methods of Oyster Culture, by Bashford Dean; and The Classification of the Myxosporidia, a group of protozoan parasites infesting fishes, by R. R. Gurley.

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Bass, Florence. Nature Stories for Young Readers. Animal Life. Boston: D. C. Heath & Co. Pp. 172. 35 cents.

Bradford, E. H., M. D., and Lovett, R. W., M. D. Distraction in Treatment of Hip Disease. Pp. 20. with Plate.

Bread from Stones. A New and Rational System of Land Fertilization and Physical Regeneration. Philadelphia: A. J. Tafel. Pp. 135. 25 cents.

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Cronise, Adelbert, Rochester, N. Y. The Pitch Lake of Trinidad. Pp. 6, with Plate.

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POPULAR MISCELLANY.

Unexplored Geographical Fields.—As among the more important fields where special geographical research may still be profitably carried on, Mr. Clements R. Markham mentions the north polar area, a vast extent of which is unknown; the south polar area, of which this is still more the case; and plenty of interesting work still in our own quarters of the globe. Even in the British islands some of the lakes were unsurveyed, and were not systematically sounded until the work was begun in Cumberland in 1893. The topography of the Alps might be considered fairly complete, but there are still physical inquiries of great interest that commend themselves to scientific Alpine travelers; such as the extent and action of ice, the oscillations of glaciers, the origin of the Föhn wind, and the effects of the destruction of forests. The historical geography of the Alps is also in process of elucidation. At present there are only three regions—in Africa—of considerable area, which offer opportunities for discovery on a large scale; namely, the Sahara, the region adjoining it to the south and extending across Wadai to the watersheds of the Congo and Nile, and the region to the east of the upper Nile, stretching south of Abyssinia, through the lands of the Gallas and Somalis, to the eastern seaboard of the continent. Outside the regions referred to we might be said to have obtained a fair knowledge of the general geographical features of the African continent. Much detail remains to be filled in, and much of the work executed in a hasty and superficial manner requires to be done over again. There are also regions of great interest that have been visited, but which would well repay detailed examination. In the continent of Asia British geographers have been very active during the present century. Perhaps the most interesting and important unknown Asiatic region is the southern part of Arabia, from Yemen on the west to Oman on the east, and between the seacoast and the states of Nejd in the interior. Hadramaut, with its lofty mountains and cultivated ravines, its settled population and historic past, is almost a sealed book to us. The exploration of this district is about to be undertaken. Much work is yet to be done in Asia Minor. The most important unexplored field includes the upper valley of the Euphrates and eastern Cappadocia.

Selection in Seed-growing.—To the seedsman, says Mr. C. L. Allen, in an address before the Horticultural Congress, published by W. Atlee Burpee & Co., Philadelphia, selection is not a cause but an effect. In the development of a type, selection is the principal agent employed, but doubly important is its office in preserving a type after it is secured. There are two separate and distinct principles in selection, and the two are antagonistic; they are both methodical, but for entirely different purposes. In the one instance we select with

a view to the greatest possible increase in seed production, and in the other for just the opposite purpose. In our cereals selections are made to produce the greatest amount of seed with the least possible amount of straw. To that end, in the best wheat-growing sections, the longest and best-filled heads are selected, and those, too, in which the grains are the heaviest, for seed purposes. The seed thus saved is given the greatest possible aid to reproduction by growing it on soil best adapted to its development; by giving each plant sufficient room to grow strong, rather than tall; and by furnishing plant food proportionate to its necessities. At the proper time, if the same careful selection is again made and the same care in cultivation given, there will result another marked improvement, both in size and productiveness of the grain. The operation, oft repeated, will establish a type superior to that from which the first selection was made. To preserve that type, the same care must be given that was necessary to produce it. In selection for vegetables, where seeds are only used to reproduce the plant, the opposite course must be pursued, and forms must be chosen that produce as little seed as possible. It has often been demonstrated that when any given type has been developed by selection, either rapidly or slowly, under favorable conditions of soil and climate, it will as rapidly revert when grown under reverse conditions. It is also true that any form that will materially revert when grown under changed conditions for a few years will proportionately change in one year. This will, in a measure, account for the deterioration of varieties where the stock seed has been grown under different conditions from those under which the type originated. In most instances one year's growth will not materially change a type, but in all cases where a type is to be preserved it requires the same care in selection and cultivation and other conditions as those under which it originated.

University Extension.—The American Society for the Extension of University Teaching looks upon the creation of a literature embodying the experience of the movement as a prime condition of its ultimate success. Such literature has been materially enriched during the last twelve months. The number of lecture courses given during 1893 was larger, and the number of people attending the courses was, in the aggregate, greater than in any previous year. An appreciable advance has been made toward bringing home the benefits of university extension to some classes of society who have for the most part thus far stood aloof from it. The society's net receipts for the year were $8,119. The programme for the last year included lecture courses on a variety of subjects in history and literature, and "class courses" on subjects in which civics and physiology and hygiene played a conspicuous part. "It is in these days of newspapers, cheap story papers, labor unions, and similar agencies," says the report, "not a question of culture or no culture; it is a question of culture of the right sort, obtained under the guidance of properly qualified teachers, or culture of the wrong sort, under the guidance of uneducated and interested parties. Which shall it be? The socialist, the anarchist, the fanatic is to-day supplying systematic culture to a large and increasing number of our population. Shall some counteracting agency be kept at work or not? No one can study the extension movement carefully, investigate what it accomplishes for individuals and communities, without becoming convinced that even if it were to go no further than providing isolated courses of lectures upon the various branches of human culture, which should be given now in one place and now in another, occurring one winter and dropping out the next, it would still be eminently worth support and maintenance."

Palæography.—Palæography—the art of identifying, comparing, and deciphering ancient manuscripts—is founded on our knowledge and experience of the development of modern forms of writing. Children at school learning to write from the same copy form hands much alike, which become differentiated according to the individual characters of the several pupils, while they still bear the marks of a common style. "Any one," says Mr. E. M. Thompson, in his Greek and Latin Palæography (published in the International Scientific Series), "will readily distinguish the handwritings of individuals of his

own time, and will recognize his friend's writing at a glance, as he recognizes his face; he has more difficulty in discriminating between the individual handwritings of a foreign country. Set before him specimens of the writing of the last century, and he will confuse the hands of different persons. Take him still further, and he will pronounce the writing of a whole school to be the writing of one man; and he will see no difference between the hands, for instance, of an Englishman, a Frenchman, and a Fleming. Still further back the writing of one century is to him the same as the writing of another, and he may fail to name the locality where a manuscript was written by the breadth of a whole continent." In the ancient Greek texts, with which palæography has largely to do, however remote the date of the documents which we are studying, Mr. Thompson observes, the impression is produced that all sorts of men wrote as fluently then as they do now. If, then, we find such evenly distributed facility in writing so far back, we must infer that the art was developed among the Greeks, or picked up by them from some other people very far back. In the earliest Greek inscriptions the writing was in the Semitic style, from right to left. This was superseded by the *boustrophedon* style, which read from right to left and left to right, in alternate lines; and that gave way to the present style. Many valuable Greek codices have recently been found. The pasteboards of the coffins discovered by Mr. Petrie at Gurob, in the Fayoum, Egypt, have furnished many. They are composed of papyri pasted together, which, being carefully separated, have been found to contain manuscripts of the third century B. C., the oldest specimens of Greek writing we have. Thus have been recovered fragments of Plato's Phædo, the lost play Antiope of Euripides, and Aristotle's Constitution of Athens, which was written on the back of an account roll of a farm bailiff in Hermopolis, A. D. 78–79. These finds are encouraging to a more systematic search of the Egyptian depositories. Of mediæval styles, no school developed the purely ornamental side of calligraphy so thoroughly and rapidly as the Irish. The finest manuscript of the style is the Book of Kells, now at Trinity College, Dublin. England is chiefly indebted to Ireland for its style, while the styles of the Roman school of missionaries were "foreign," and never became fully naturalized. The round hand was chiefly used for books and charters, while the pointed hand, though also employed for books, was most frequent in documents. These hands gradually suffered changes and degeneration, were affected and partly displaced by the French minuscule, and hence gradually became differentiated into the multitude of nondescripts that now pass for English handwriting.

The Grand Falls of Labrador.—An account of his visit to the Grand Falls of Labrador has been given by Henry G. Bryant, of Philadelphia, in the Century Magazine and in a Bulletin of the Geographical Club of Philadelphia. They are situated on the Grand or Hamilton River, which rises in the lakes of the upland region of the peninsula and flows in a general southeasterly direction into Hamilton Inlet—the great arm of the sea which, under various names, penetrates into the interior a distance of one hundred and fifty miles. No scientific explorer has advanced far into the country, and all that is known of it is derived from vague information furnished by Indians, a few missionaries, and the Hudson Bay Company's men. The first white man to visit and describe the falls was John McLean, of the Hudson Bay Company, in 1839. They were visited twenty years afterward by Joseph McPherson. These are the only white men who are known to have seen the Grand Falls till the summer of 1891, when Mr. Bryant and an expedition from Bowdoin College reached them independently of one another. Mr. Bryant, accompanied by Prof. C. A. Kenaston, of Washington, and a Scotch and an Indian assistant, left Northwest River Post, at the head of Hamilton Bay, on August 3d, to proceed up the stream by canoe. On the 27th they reached the point where the further navigation of the stream is obstructed by rapids, whence they proceeded overland and reached the falls September 2d. "A single glance showed that we had before us one of the greatest waterfalls in the world. . . . A mile above the main leap the river is a noble stream four hundred yards wide, already flowing at an accelerated speed. Four rapids, marking successive depressions in the river

bed, intervene between this point and the falls. At the first rapid the width of the stream is not more than one hundred and seventy-five yards, and from thence rapidly contracts until reaching a point above the escarpment proper, where the entire column of fleecy water is compressed within rocky banks not more than fifty yards apart. Here the effect of resistless power is extremely fine. . . . An immense volume of water precipitates itself over the rocky ledge, and under favorable conditions the roar of the cataract can be heard for twenty miles. Below the falls, the river, turning to the southeast, pursues its maddened career for twenty-five miles shut in by vertical cliffs of gneissic rock which rises in places to a height of four hundred feet. The rocky banks above and below the falls are thickly wooded with firs and spruces, among which the graceful form of the white birch appears in places." The height of the falls was found, by as accurate a measurement as could be made with cord, to be three hundred and sixteen feet. The highest elevation reached by the expedition was in the vicinity of the falls, and appeared by aneroid measurement to be somewhat in excess of fifteen hundred feet. From the point where the river leaves the plateau and plunges into the deep pool below the falls, its course for twenty-five miles is through one of the most remarkable cañons in the world. Besides the topographical and meteorological data, valuable botanical collections and ethnological collections illustrating the life and customs of mountaineer (Montagnais) Indians and Eskimos were obtained.

Hair Stimulants.—The best promotive of hair growth is general vigor, which, prevailing where hair should be as well as in the rest of the body, stimulates its development along with that of other functions. For baldness, hair lotions containing cantharides, attracting an increased blood supply to the part, may be useful when the affection is caused by mere sluggishness of the cutaneous circulation; but it fails to reach the cause of disease where the hair is lost through seborrhœa. Such cases are benefited by remedies which kill microbes, such as sulphur, mercurial applications, and antiseptic drugs. The effect of the microbe on the greasy and dry scales in seborrhœa which causes proliferation of the epithelium is such as to lead to atrophy of the hair, and if the disease is not arrested, atrophy of the whole follicle, and consequent permanent alopecia. Where the damage to nutrition is not so great, the hair is without luster and turns more or less gray, and then the hair restorers which color the hair from without and not from within are resorted to. Sulphur and acetate of lead are often ingredients of these applications, and perchloride of mercury is too frequently the leading constituent of many vaunted remedies. It is doubtless of much value as a destroyer of microbes when used in suitable cases, but when applied indiscriminately for long periods is in danger of producing injurious effects. Pilocarpine hypodermically injected, or given internally as tincture of jaborandi, is of value as a promoter of growth of hair, but is too powerful a remedy for indiscriminate use, besides inducing copious perspirations and depression of the heart. Less direct means may be found in tonics of iron, strychnine, quinine, etc.; but more powerful are cod-liver oil and change of air, generally to a bracing climate. Baldness is, however, a symptom of such diverse conditions that there is no routine treatment for it, but the cause should be carefully sought out and intelligently dealt with.

Hygiene of the Teeth.—Writing of the hygiene of the teeth, the Lancet observes that all caries of the teeth begins from without, no such thing as internal caries having ever been demonstrated; hence, if the surfaces could be kept absolutely clean there would be no decay. To the question, "When ought the cleansing of the teeth to begin?" the certain answer is, "As soon as there are teeth." "A small toothbrush, charged with some precipitated chalk flavored with an aromatic drug to make it pleasant, is perhaps the best means—not a towel, which only removes the secretion from the labial and lingual surfaces and not from between the teeth, where decay is most rife." If this habit is acquired early, the very desirable result is likely to follow of immunity, to a greater or less extent, from dental trouble. Later on something more can be done by passing a piece of waxed dental floss

silk between the teeth every day. Toothpicks may do harm if abused, by causing irritation of the gum between the teeth, and its consequent absorption; and if the picks are made of wood, splinters are liable to be left behind, which have in many cases caused even the loss of a tooth; but used judiciously they are of great value in routing the attacking forces in caries—namely, accumulations of food and mucous secretions. It has been urged against them that they might dislodge a filling; but if a filling is so insecure it must be faulty, and the sooner it is replaced the better, for decay, due to the impossibility of keeping the surface clean, must be going on underneath it.

A Foot, Stilt, and Horse Race.—A race between three pedestrians, three stilt walkers, and three horses took place from Bordeaux, France, early in May, over a course, returning to Bordeaux, of four hundred and twenty kilometres. At ninety-one kilometres the horses were ahead, one an hour and a half in advance of the third; the stiltmen were behind them, and the pedestrians were far in the rear, with one of them dropped from the course. At one hundred and fifty kilometres a stiltman had got ahead of one of the horses. At one hundred and sixty-six kilometres one of the horses was taken out ill, and the horse which had been passed by a stilt walker had caught up with him. At two hundred and thirty-five kilometres the pedestrians had given up the struggle. At three hundred and five kilometres the rivals were the leading stilt walker and the horse which he had once passed, the other horse beginning to fail. The rivalry between the stilt walker and horse was kept up till the end of the race, when the horse came into Bordeaux twenty-eight minutes ahead. The time was sixty-two hours and twenty-seven minutes.

Marine Silk.—To the various kinds of silks known in trade must now be added, according to the French journal L'Industrie textile, a marine silk, derived from shells, or from the filaments, technically known as the *byssus*, which are secreted by some mollusks, including the mussels, which fasten themselves to the rocks. These filaments are very strong, as one may easily find out by trying to pull apart a cluster of mussels attached by them to one another. Though very fine, the filaments of the mussel shells are generally too short to be of much use; but they are long enough in some kinds, among which is a *pinna* very common in the Mediterranean and known to French fishermen as the *jambonneau*, or little ham, from its peculiar shape and color. These shells are raked up from a depth of between six and nine metres near the coast of Sicily. The threads are slender but extremely tough, and a considerable effort is required to detach them from the rock. The tuft, having been detached from the shell, is washed in soapsuds and dried in the shade. The useless parts are cut away, and the available threads are rubbed in the hands to give them suppleness, and then sorted and separated by combing—an operation in which a waste of about two thirds of the raw material is incurred. Two or three of the threads are spun with a thread of silk, whereby a very strong cord is obtained. The cord is washed in water acidulated with lime juice, rubbed again with the hand, and smoothed with a hot iron, by which it is finally given a beautiful brownish gilt color.

John Wesley an Evolutionist.—It will probably be a novel idea to our Methodist friends to find in John Wesley a precursor of Spencer and Darwin in outlining the doctrine of evolution. This has, nevertheless, been done by William H. Mills, in a paper read before the Chit Chat Club of San Francisco, entitled "John Wesley an Evolutionist." Mr. Mills exhibits as his authority a work entitled Wesley's Philosophy, in two volumes, which was published by the Methodist Book Concern in New York in 1823. In this work, in which Mr. Wesley expressed himself as believing that he was presenting only such matters as had been established by investigation and research, he says: "The same general design comprises all parts of terrestrial creation. A globule of light, a molecule of earth, a grain of salt, a particle of moldiness, a polypus, a shell-fish, a bird, a quadruped, and man, are only different strokes of this design, and represent all possible modifications of the matter of our globe. My expression falls greatly beneath reality; these various productions are not different strokes of the same design; they are

only so many points of a single stroke, that by its infinitely varied circumvolutions traces out to the astonished eyes of the cherubim the forms, proportions, and concatenations of all earthly beings. This single stroke delineates all worlds." Mr. Wesley says again: "All is metamorphosis in the physical world. Forms are continually changing. The quantity of matter alone is unvariable. The same substance passes successively into the three kingdoms. The same composition becomes by turns a mineral, plant, insect, reptile, fish, bird, quadruped, man." Further, Mr. Wesley spoke of the bat and flying squirrel as animals "proper for establishing the gradation that subsists between all the productions of Nature"; of the ostrich as seeming to be "another link which unites birds to quadrupeds"; and of the ape as a rough draught of man. He also considered the most primitive form of organic life as the connecting link between the animal and the vegetable to be the polypus. It did not occur to Mr. Wesley that man as the result of evolution had a debased origin, but he went on to say: "Has God created as many species of souls as of animals? Or is there only one species of soul in animals, differently modified according to the diversity of organization? This question is absolutely impenetrable by us. All we can say concerning it is this: If God, who has always acted by the most simple means, has thought proper to vary the spiritual perfection of animals merely by organization, his wisdom has so ordained it. At the summit of the scale of our globe is placed man, the masterpiece of earthly creation." Further: "Mankind have their gradations as well as the other productions of our globe. There is a prodigious number of continued links between the most perfect man and the ape."

Tropical Animals in Frost.—The animals in the London Zoölogical Gardens were surprised by a hard frost (16°) in the last days of November, 1893, but, according to an observer who was there to see, the animals from warm and tropical regions seemed no more inconvenienced by the cold than were their fellow-residents from far northern regions. With every pond and pool sheeted with ice, and the gravel walks as hard as granite, birds and beasts from such regions as Burmah, Assam, Malacca, and Brazil "were abroad and enjoying the keen air; and others, which are usually invisible and curled up in their sleeping apartments until late in the day, were already abroad, sniffing at the frost and icicles, and as Mr. Sam Weller's polar bear 'ven he was a-practicing his skating.' A visit to the Gardens in such weather suggests a modification of too rigid ideas of the limitation of certain types of animals to warm or torrid climates, and illustrates the gradual and reluctant character of the retreat of species before the advance of the glacial cold in remote ages. No creatures are, as a rule, more sensitive to cold than the whole monkey tribe. Yet there is at least one species of monkey which habitually endures the rigors of a northern winter. One of the cleverest antique Chinese drawings at South Kensington represents a troop of monkeys caught in an avalanche of snow. The grotesque discomfiture of these pink-faced monkeys rolling down the hillside, helplessly clutching at each other's bodies and tails, grinning and grimacing as their heads emerge from the powdery snow, is something more than the fancy of a Chinese painter. The incident is probably drawn from an actual scene, and one of the creatures, the Scheli monkey from the mountains of Pekin, was in an open cage in the Gardens, and in far better health and spirits than in the height of summer. Its fur had grown thick and close, and the naked face had assumed the dark madder-pink with which it was adorned in the Chinese drawing. When presented with sticks crusted with hard ice, it sucked the chilly dainty with great relish, and only showed signs of sensitiveness to cold by putting its fingers to its mouth, then sitting on its hands to warm them. The behavior of this northern monkey is only strange by contrast with the general habits of its kind. But the indifference to cold of the capybara, a gigantic water guinea pig from the warm rivers of Brazil, is not easy to explain. Two of these quaint creatures had left their snug sleeping apartments, and were stepping gayly among pools of half-frozen water and broken ice. One had gained an extra coat by burrowing in its straw and then emerging with a pile upon its back; and when this fell off, retired and shuffled on another pile; but the

other seemed quite contented to sit without protection in the sunniest corner of the inclosure. The whole colony of porcupines (six in number) . . . were abroad and in the highest spirits, erecting and rattling their quills, and sitting up to inspect their visitors like gigantic rabbits." The demeanor of the semitropical birds was even more interesting than the power of adaptation to climate shown by quadrupeds. The Argus cock-pheasant from Sumatra or Borneo "was displaying its beauties in the open air, among leaves and grass tipped with icicles, and showed plumage so close and perfect that it was impossible to doubt that the colder climate had, if anything, added a luster to its unrivaled wealth of ornament."

Mental Growth through Physical Education.—In a paper on Mental Growth through Physical Education Jakob Bolin begins his argument by showing how muscular work, or physical exercise, serves to keep the metabolism of the body at a proper level. Then it operates on the mind thus: "When you are sitting at your desk for any appreciable length of time, sunk in profound thoughts, these thoughts, however pure and lofty, are actually slowly poisoning your brain, decreasing its aptitude to the work at hand, and you will find, as time passes, that you are not able to keep your attention fixed, your will power has lost its grip, your memory is deteriorated, you can not grasp an idea as before, and there creeps over you a certain feeling of lassitude and dullness; your temples throb, your face is flushed, there is a sensation of fullness, your head aches. And all this because your thoughts—your mental work—have pumped up into your head a quantity of blood giving the necessary fuel for these thoughts, but there has been no agent at work strong enough to remove the ashes and refuse. But rise from your table, take a few deep inhalations, move your arms in rhythm with the respiration, walk for a quarter of an hour, and you will probably find the unpleasant symptoms gone and yourself ready to begin anew; your attention, which was wandering, has become fixed, your will power is stronger, your memory its own self, your ideas from vague have become more clear and your conclusions more logical. And the temporary beneficial effects of occasional muscular work are easily made permanent by applying the remedy steadily and systematically." Another purpose than this is also served in systematic gymnastics, in which a uniformity of movement and a definite rhythm are cultivated. By these "we endeavor to teach our pupils to have, by means of their muscular sense, a due appreciation of the proper order of things and also to do things exactly each at its proper time, to let things follow each other in a previously arranged order, to complete one thing before they undertake a new enterprise; we teach them also by the same means not to feel as if each were a completeness by himself, but try to let them acquire the habit of considering themselves as units of a greater whole, which suffers if not each unit works with the aim in view of gaining the greatest perfection for the whole. In the gymnasium each one must subordinate himself to the welfare of his class; in the baseball field that sensation of identification with the team is created; in the rowboat each works in harmony with everybody else; and thus, through evolving this feeling of belonging together, we hope to react favorably upon the doings of these same individuals as units of a greater whole, the community, the nation, humanity, so as to direct their mental as well as physical capacities toward the common welfare, toward the progress of the race, to make not a better man but better men."

Domestic Birds of the Chinese.—Fowls form a considerable part of the food of the better classes in China, and the breeding and rearing of them constitute an important industry. Four varieties of fowls are described in the report of the United States consul at Ching Kiang, each of which has its peculiar characteristics and qualities. Of the smallest of the breeds, the *chow*, a white cock, is carried on the coffin at funerals and is sacrificed at the grave; and it is customary on the native boats to kill one on New Year's day and sprinkle the blood on the bow for the propitiation of evil spirits and to insure good luck during the year. Ducks are reared in great numbers, and are largely used as food, both fresh and salted. They are all artificially hatched. After fledging, the birds are driven about in flocks through canals and from pond to pond, where they find their food. They

are brought under strict discipline, and obey their keeper's call with extraordinary intelligence. The mandarin duck, a smaller variety, is reared for its beauty, and is prized as an embellishment to the artificial lakes with which the grounds of the wealthy are adorned. By virtue of their repute for conjugal fidelity a pair of them are introduced into wedding processions. The eggs, preserved by a peculiar process, after which they will keep for several years, form an important part of mandarin dinners. Geese, pure white, and of great size and majestic carriage like that of the swan, are bred; turkeys for foreigners and gold and silver pheasants are raised, and the cormorant is domesticated and trained to a wonderful degree of intelligence for fishing. The birds are taken out on the lakes and rivers in a small boat, one man to every ten or twelve cormorants. They stand perched on the sides of the boat, and at a word from the man they scatter on the water and begin to look for their game. They dive for the fish, and then rise to the surface with the catch in their bills, when they are called back to the boat by the fisherman. As docile as dogs, they swim to their master and are taken into the boat, when they lay down their prey and again resume their labor. The use of incubators in hatching eggs has been known and practiced in China for several hundred years, as it was also in ancient Egypt. The apparatus is described as very primitive; but the men engaged in the business know exactly the day when the young ducks or chickens will come forth, and are prepared to receive them.

NOTES.

It is the habit of centipeds to carry their young, clasped by means of their legs, to all parts of the under side of the body, though generally the young are clustered in dense masses. When the young are thus bunched together the body is coiled upon itself at that part; and the contrast between a centiped in this position, says Mr. J. J. Quelch, who describes the centiped's method in Nature, and a scorpion carrying her young upon her back, just as a small opossum does, is a very marked one.

The *sumpitans* or blowpipes of the Jakuns living on the Serting River in the sultanate of Johore are manufactured from a very long-jointed, straight variety of bamboo, which is generally carved and traced with many rude devices. The darts consist of thin splinters of wood about a foot long, having a plug of pith at the blunt end. The point is as sharp as a needle, and is covered with a black, resinous substance, which is in many cases extremely poisonous. Monkeys and other small animals die from its effects almost immediately; on man and the larger animals its action is less rapid, but quite as deadly. The poison is known to the Malays as *ipoh*.

An active discussion was had in the British Association on the question of the criterion by which a flint should be regarded as the work of man or of Nature. With regard to the ruder forms of what some extreme anthropologists include among palæolithic implements opinion was much divided; as it was also on the point as to how far the position in which such implements, even when recognized as artificial, are found can be accepted as an indication of their age. The moral suggested by the discussion is that many flints have been accepted as the handiwork of man on the most inadequate evidence, and that there is still much doubt as to whether man existed in the British islands in preglacial times.

Photographic records taken with the aid of the capillary electrometer of electric currents produced by speaking into the telephone were exhibited by Mr. Burch in the British Association. The letter *z* produced a complicated curve in which oscillations of current lasting only one three-thousandth of a second were visible with a lens. The speaker said that the electromotive force produced in using the ordinary telephone amounts to about one tenth of a volt; but with emphatic syllables it may rise high enough to produce electrolysis.

The question whether the intensity of the radiation of heat by the sun is affected by its condition as to spots has been studied by M. R. Savelief, of Kiev, in the light of observations made in the spring and the fall of the years 1890, 1891, and 1892. The results point to an affirmative answer, the radiation being greater as the sun-spot activity augments. A variation in one series of the experiments is interpreted as indicating that the increase is dependent, not so much on the absolute number of the spots as upon the intensity of their evolution; or it may mean that it is immediately consecutive on their diminution.

The meeting of the British Association at Oxford was attended by 2,311 persons, several hundred more than attended last year's meeting; and the receipts were £2,175. Appropriations of £1,100, or about £100 more than usual, were made for grants for research. The committee of recommendations proposed that Section D be called zoölogy instead of biology; that a separate section be consti-

tuted for botany; and that Section I consist of physiology with experimental pathology and experimental psychology.

THE results of certain experiments concerning the effect of various forms of distraction upon memory, reported by W. G. Smith to the British Association, show that the memory is most efficient when the subject is allowed to learn various combinations of the alphabet without distraction of any kind. But the power of recollection is lessened to some extent by regular movements of the forefinger made by the subject while he is learning; still more by the simultaneous articulation of an unintelligible syllable; and most of all by the performance of simple addition during the experiments.

THE committee of the British Association on an International Standard for the Analysis of Iron and Steel has reported, through Prof. W. C. Roberts Austin, that the composition of the remaining, before undetermined standard, No. 5, has now been determined by four different analysts, and is accurately ascertained. The standards will shortly be deposited with the Board of Trade, when the work of the committee will have been completed.

A MUSEUM of journals at Aix-la-Chapelle, Germany, founded in 1886 by M. Oscar Forkenbeck, is said to contain already five hundred thousand journals in all languages. The founder devoted his whole fortune for forty years to the acquisition of rare and curious specimens, and to subscriptions to journals in all parts of the globe. He received and read every day a considerable number of papers in thirty different languages. Having started the museum with ten thousand full collections, he addressed a circular letter to the press of the globe asking co-operation in his enterprise, and a large number of journals responded favorably.

IN certain experiments made by him, Mr. L. Cobbett found that tissues which had once been the seat of erysipelas retained the power of reacting more energetically than normal tissues when inoculated with the sterilized products of cultures of the erysipelas organism. He suggested that immunity might be explained as being due to an ability on the part of the tissues to react to chemical substances produced by bacteria.

SIR JOHN MURRAY reports that the study of the weather at Ben Nevis and Trieste has led to the isolation of two types of weather —namely, perfectly clear days and those on which some fog exists. The two types correspond to quite different characters in the hourly variation of temperature and pressure.

AN extraordinary migration of "Croton bugs" was described by L. O. Howard in the American Association as witnessed by him in Washington one very dark day last summer. The migrating army, composed of many thousands of individuals, consisted almost entirely of female roaches carrying egg-sacks. An investigation of the circumstances led him to the conclusion that the observation indicated a development of the true migratory instinct, and that while the old residence of the insects might have supported its then occupants, provision for the sustenance of the young, as yet unborn, necessitated a journey in search of new quarters. The migration of this army upon a dark day suggested that it is by similar expeditions after nightfall that new houses become infested with roaches.

ALUMINUM has the property, when used as a pencil, of leaving an indelible mark on glass or any other substance having a siliceous base. A deposition of the metal takes place, and, while this may be removed by a suitable acid wash, the mark itself can not be removed by rubbing or washing. Magnesium, zinc, and cadmium have a similar property, but the mark of magnesium is easily removed, the application of zinc requires a wheel, and zinc and cadmium tarnish; while aluminum is permanent and remains bright. This property is susceptible of a variety of practical applications in decorating glass.

IN his address before the Section of Geology of the British Association Mr. L. Fletcher suggested the importance to a highly civilized country of having within its own borders men who would make themselves familiar with all that was being done and had been done in the subject, would do what was possible to fill up the gaps in the science, and would make the results available for those who had not the opportunity to make so complete and original a survey for themselves. He recommended that by some means each university should be enabled to endow a professorship of mineralogy in such a way as to attract the most capable men to the study of the subject; and he pointed to the example lately set by Cambridge, which encouraged the students of physics, chemistry, and geology to acquire a knowledge of mineralogy and crystallography, and gave them credit for that knowledge in the examination for a degree.

As a result of elaborate investigations, Dr. J. S. Haldane has come to the conclusion that in colliery explosions the deaths from suffocation are due, not, as is generally supposed, to carbonic-acid gas, but to the preponderance of nitrogen and the deficiency of oxygen. Life could be saved if the colliers could be supplied with oxygen for an hour or so; and the author has devised an apparatus for enabling a man to breathe oxygen, of which sixty litres are compressed into a half-litre bottle, with tube and regulating taps, supplemented by a wire compress for the nose to prevent breathing through that organ.